ANVIK RIVER SALMON ESCAPEMENT STUDY, 1993

By

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

LIST OF APPENDICES

ABSTRACT

Since 1979 the Anvik River sonar project has estimated daily passage of summer chum salmon *Oncorhynchus keta* using side-scanning sonar counters. During the period 19 June through 27 July 1993, an estimated 517,409 summer chum salmon passed the sonar site on the Anvik River. This estimate is 3% above the minimum escapement objective of 500,000 salmon. Overall, the 1993 summer chum salmon run was late, with a very protracted middle portion. Specifically, timing of the 1993 run was late for all quartile passage days compared to the long-term mean (1979-1992, excluding 1986) timing statistics of the run. The first quartile passage day was 2 d later than the long-term first quartile day; the median passage day was 4 d later; and third quartile passage day was 5 d later than the long-term average. The third quartile passage day occurred on 18 July which was the latest on record by 2 d. Female chum salmon comprised an estimated 52.0% of the summer chum salmon passage. Age-4 fish comprised an estimated 64.8% of the passage; age-5 fish accounted for 32.4%. Age-4 salmon dominated all sampling strata increasing to 72% in the final stratum. Male salmon dominated the first sampling stratum; female salmon dominated the third and final stratum. A total of 1,526 chinook salmon *O. tshawytscha* were enumerated on an aerial survey of the mainstem index area within Anvik River drainage. This count is 3 times above the minimal escapement goal of 500 chinook salmon for this index area. Age-6 salmon accounted for 45.6% of the chinook salmon escapement; age-5 salmon accounted for 41.0% based on carcass samples. Male chinook salmon dominated the escapement, accounting for 57.9% of the sample.

INTRODUCTION

Two distinct runs of chum salmon *Oncorhynchus keta*, summer and fall, spawn in the Yukon River drainage. The Anvik River (Figure 1) is the largest producer of summer chum salmon in the Yukon River drainage. Buklis (1982a) estimated that the Anvik River alone accounts for 35% of the total production. Other known major spawning populations occur in the Andreafsky, Rodo, Nulato, Gisasa, Hogatza, Melozitna, Tozitna, Chena, and Salcha Rivers (Figure 1). Summer chum salmon spawn in lesser numbers in other tributaries of the Yukon River. Chinook *O. tshawytscha* and pink *O. gorbuscha* salmon occur in the Anvik River coincidentally with summer chum salmon. Coho salmon *O. kisutch* spawn in the Anvik River drainage during the fall.

Harvest of Anvik River Salmon

Commercial and subsistence harvests of Anvik River summer chum salmon occur throughout the mainstem Yukon River from the coast of the delta to the mouth of this tributary stream at river kilometer (rkm) 513. This section of river includes Districts 1, 2, 3 and the extreme lower portion of District 4 (Figure 1). Set and drift gillnets are the legal fishing gear in Districts 1, 2, and 3; set gillnets and fish wheels are used in District 4. Most of the effort and harvest on the Anvik River stock occurs in Districts 1 and 2 and in the extreme lower portion of District 4 below the confluence of the Anvik and Yukon Rivers. Fish taken commercially in the lower three districts are sold in the round; District 4 is primarily a roe fishery because of poor flesh quality and distance from market. Subsistence fisheries in Districts 1, 2, and 3 take summer chum salmon primarily for human consumption. Subsistence harvest of summer chum salmon in District 4 is primarily for sled dog food. Commercial and subsistence summer chum salmon fisheries in the remainder of District 4 and in District 6 are supported by stocks other than the Anvik River stock. Very few summer chum salmon are harvested in District 5 because of the lack of spawning populations in that portion of the drainage.

In the lower portion of the Yukon River (Districts 1, 2, 3), run timing of chinook and summer chum salmon greatly overlap from river-ice breakup through June or early July. During this period, management of the lower Yukon River has traditionally been directed at chinook salmon. The District 4 commercial fishery has been directed primarily at chum salmon. In the Lower Yukon Area, large-mesh gillnets (stretch mesh greater than 6 in) were employed to harvest chinook salmon. Although these were very efficient for chinook salmon, the associated harvest of summer chum salmon through 1984 was small in relation to the size of the run. Therefore, prior to the 1985 season, the Alaska Board of Fisheries, in an attempt to increase the harvest of summer chum salmon in the lower river, directed that special small-mesh (stretch mesh maximum of 6 in) fishing periods be allowed during the chinook salmon season provided that (1) the summer chum salmon run was of sufficient size to support the additional exploitation, and (2) the incidental harvest of chinook salmon during these small-mesh fishing periods did not adversely affect conservation of that species.

A poor summer chum salmon run to the Yukon River in 1987 prompted fishery managers to consider the summer chum salmon fishery as fully developed (Sandone 1991). However, strong runs during the next 2 years resulted in record commercial harvests of 1,620,269 summer chum salmon in 1988 and 1,456,928 in 1989 (Bergstrom et al. 1992). Distribution of the summer chum salmon catch among districts reflected stock distribution, market demand, and scheduled fishing time. Without harvest guidelines, increased market demand prompted allocation disputes between district fishermen. Additionally, fishery managers were perceived by some of the public as making resource-allocation decisions by scheduling fishing time. To address these problems the Alaska Board of Fisheries, in February 1990, established a river-wide guideline harvest range of 400,000 to 1,200,000 summer chum salmon (ADF&G 1990). This overall guideline was distributed by district and subdistrict based on the previous 15-year average harvests.

Based on evaluation of brood year escapements and assuming average survival, it was expected that the Yukon River summer chum salmon run in 1993 would be below average to average in magnitude (ADF&G 1993). Accordingly, the river-wide commercial harvest was expected to be between 400,000 to 800,000 summer chum salmon (ADF&G 1993).

Stock Identification Studies

Two stock identification studies have been conducted on Yukon River chum salmon stocks. Initially, a small-scale stock identification investigation using scale pattern analysis was conducted by the Alaska Department of Fish and Game (ADF&G). Results of this pilot study indicated that separation of chum salmon stocks by scale pattern analysis was probably not feasible (Wilcock 1988). A more recent stock identification study (Wilmot et al. 1992) reported success in separating Yukon River chum salmon stocks using protein electrophoresis techniques. This study was initiated in 1987 by the United States Fish and Wildlife Service (USFWS) and continued through the 1991 season. Preliminary results indicated that among all represented chum salmon stocks of the Yukon River, two major groups were apparent, a summer-run group and a fall-run group. These investigators also reported that within the summer-run group, two major subdivisions were apparent, those of the lower river below rkm 800 and those of the mid river (rkm 800-1,150). Wilmot et al. (1992) reported that estimated stock compositions of samples collected from District 1 commercial and test net fisheries during 1987 to 1990 indicated that the lower river summer-run chum salmon stocks contributed 75-100% to the catch until mid-July.

During the 1987 and 1988 field season, chum salmon genetic stock identification (GSI) collections were obtained at the mainstem Anvik River sonar site. Interestingly, these two collections were significantly different genetically (Wilmot et al. 1992). Although the collection obtained in 1987 was genetically similar to the lower river summer-run group, the collection obtained in 1988 was reported to be a separate group within the summer-run group and genetically distinct from the lower and mid-river groups (Wilmot et al. 1992). These investigators speculated that because the Anvik River is a large, productive river system that probably supports numerous spawning stocks, the mainstem collections at the sonar site in 1987 and 1988 most likely included different combinations of upriver, genetically distinct stocks. This apparent under-representation of Anvik River sub-populations in the genetic baseline data set was identified as one of the limitations of the study (Wilmot et al. 1992). Presently, GSI studies on chum salmon within the Anvik River are focusing on sampling tributary populations of chum salmon in order to expand the chum salmon baseline.

Escapement Assessment

Accurate salmon escapement assessment on Yukon River tributaries are important for regulating fishery harvests, setting escapement goals, evaluating the effectiveness of management programs, and providing information for use in projecting subsequent returns. However, because of the vast size of the Yukon River drainage, 853,000 km^2, estimating escapements to more than a few tributaries is economically infeasible. Consequently, most escapements are instead assessed using low-level aerial surveys conducted from single-engine, fixed-wing aircraft. These aerial surveys are subject to errors and year-to-year variability associated with weather, stream conditions, timing of the survey relative to spawning stage, and observer subjectivity and experience. The counts obtained are only indices of abundance because the entire escapement is not present on the day of the survey and not all the fish present are seen and counted. Attempts to standardize the conditions under which these indices are conducted improves their usefulness in monitoring the relative abundance of spawning escapements.

Chinook salmon escapements to the major spawning areas in the Yukon River drainage have been estimated by aerial survey from fixed-wing aircraft on a consistent basis since the early 1960s, and chum salmon escapements since the early 1970s. Escapement goals based on aerial surveys have been established for both chinook and chum salmon in selected tributary streams for which there is a sufficient historical database (Schultz et al. 1993).

Comprehensive escapement assessment studies have been conducted on only a few selected spawning streams for each run of chum salmon in the Yukon River drainage. The Anvik River was chosen for summer chum salmon research studies in 1972 and the Andreafsky and Melozitna Rivers (Figure 1) in 1981. However, because of budget restrictions, the Melozitna River project was discontinued in 1984, and the Andreafsky River project was discontinued in 1989.

Study Area

The Anvik River originates at an elevation of 400 m and flows in a southerly direction approximately 200 km to its mouth at rkm 513 of the Yukon River. It is a narrow runoff stream with a substrate mainly of gravel and cobble. However, bedrock is exposed in some of the upper reaches. The Yellow River (Figure 2), a major tributary of the Anvik, is located approximately 100 km upstream from the mouth of the Anvik River. Downstream of the confluence of the Yellow and Anvik Rivers, the Anvik River changes from a moderate gradient system to a low gradient system meandering through a much broader flood plain. Turbid waters from the Yellow River also greatly reduce the water clarity of the Anvik River below this confluence. Numerous oxbows, old channel, cutoffs and sloughs are found throughout the lower river.

Anvik River salmon escapement was partially enumerated from two counting tower sites from 1972 to 1979 above the confluence of the Anvik and Yellow Rivers (Figure 2). A site 9 km above the Yellow River on the mainstem Anvik River was used from 1972 to 1975 (Lebida 1973; Trasky 1974, 1976; Mauney 1977). From 1976 to 1979 a site on the mainstem Anvik River near the confluence of Robinhood Creek and the Anvik River was used (Figure 2; Mauney 1979, 1980; Mauney and Geiger 1977). Other than 1974, aerial surveys were flown each year in fixed-wing aircraft to estimate salmon abundance below the tower site. High and turbid water often affected the accuracy of visual salmon enumeration from counting towers, as well as from aircraft on the Anvik River.

The Electrodynamics Division of the Bendix Corporation[2] developed a side-scanning sonar counter during the 1970s capable of detecting and counting salmon migrating along the banks of streams. A pilot study using side-scanning sonar to estimate chum salmon escapement to the Anvik River was conducted in 1979. Results of this study indicated that sonar enumeration of chum salmon escapements to the Anvik River was superior to the counting tower method (Mauney and Buklis 1980). Therefore, in 1980, sonar enumeration replaced the tower counting method for estimating summer chum salmon escapement.

The Anvik River sonar site is located approximately 76 km upstream of the confluence of the Anvik and Yukon Rivers (Figure 2). Project results for escapement studies using sonar technology on the Anvik River from 1979 to 1992 have been reported by Mauney and Buklis (1980), Buklis (1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987), and Sandone (1989, 1990a, 1990b, 1993, 1994). This report presents results of the Anvik River summer chum salmon escapement study for the 1993 field season.

Objectives

Because the majority of the subsistence harvest and some of the commercial summer chum salmon harvest occur in the Yukon River drainage above the mouth of the Anvik River, it is important to accurately assess the strength of the upriver run so that escapement and harvest needs can be met. The information derived from this project, in conjunction with Yukon River sonar passage estimates and subsistence and commercial catch rates, has been used to assess the strength of the Yukon River summer chum salmon run above the mouth of the Anvik. The timely and accurate reporting of information from the Anvik River sonar project is a critical component of Yukon River summer chum salmon management. The primary purpose of this project is to monitor the escapement of summer chum salmon to the Anvik River. The two primary objectives of this project are to:

1. estimate the daily summer chum salmon escapement passing the Anvik River

[2]Use of a company's name does not constitute endorsement.

sonar site; and

2. estimate the age and sex composition of the summer chum and chinook salmon spawning escapements.

METHODS

Sonar Deployment and Operation

A sonar counter has been installed and operated on each bank of the Anvik River near Theodore Creek (Figure 2) each year since 1979. The sonar counter operates by transmitting a sonic beam along an 18-m aluminum tube, or substrate. Echoes from salmon passing through the beam are reflected back to the transducer. The system electronics interpret the strength and number of the echoes, and tally salmon counts. Criteria for strength and frequency of the echoes are designed to count salmon and minimize non-salmon counts (i.e., debris or other fish species). Aerial survey data indicate that virtually all summer chum salmon spawning activity is located upstream of this site.

During the 1993 season, a 1981-model sonar counter was deployed and operated according to guidelines described by Bendix Corporation (1981) on each bank of the Anvik River to enumerate summer chum salmon passage. Sonar counters were operated without the prescribed artificial aluminum substrate tubes throughout the season. This practice of operation without an artificial substrate was first employed on the Anvik River in 1986 (Buklis 1986). The east and west bank sites used in previous years were probed to locate uniform river bottom gradients that would provide optimum surfaces for ensonification. Each sonar transducer was mounted on a rectangular aluminum frame. Two steel pipes were set into the river bottom on each side of the river, onto which the transducer frames were guided by side-mounted steel sleeves. Sandbags were placed on top of the transducer housing to ensure stability. Sonic beams emitted from each transducer were aimed perpendicular to shore; transducers were offset to prevent interference between units. To prevent fish passage inshore of the transducer, weirs constructed of T-stakes and rectangular mesh fencing were installed perpendicular from the shoreline and downstream of the transducer; they extended from the shore to approximately 1 m beyond the transducer. Counting towers of aluminum scaffolding material approximately 3 m in height were placed near the transducers on each bank for visual observation of salmon when water conditions permitted. Transducers were moved inshore or offshore, as required by fluctuating water levels. Consequently, depth at the transducer varied throughout the season. Transducers were aimed and counting range lengths were adjusted so that echoes resulting from the stream bottom or surface interface did not register as counts by the sonar electronics.

The 1981-model counters used on the Anvik River sonar project divided the counting range, or ensonified zone, into 16 sectors of equal length. Sector length was dependent on the length of the counting range. Sectors were consecutively numbered from the west (right) to east (left) bank. Therefore, sectors 1-16 were associated with the west bank counter, and sectors 17-32 were associated with the east bank counter. Sector number 1 and 32 corresponded to the nearest sectors to each bank.

The east bank transducer was located along a cutbank approximately 60 m above the field camp site. Initial placement of the east bank transducer was approximately 1.0 m offshore and at a depth of 1 m. The west bank transducer was located along a gradually sloping gravel bar, approximately 3 m downstream of the east bank transducer. Initial placement of the west bank transducer was approximately 9.0 m offshore and was also in water about 1 m deep.

Sonar Calibration and Sampling

Each sonar counter was usually calibrated four times daily by observing fish passage using an oscilloscope. Salmon passing through the sonar beam produce a distinctive oscilloscope trace or spike. During each calibration period counts of salmon enumerated by the observer using the oscilloscope were compared to counts recorded by the sonar electronics. The fish velocity control setting on the sonar counter was adjusted immediately after a calibration if the oscilloscope:sonar counts ratio varied from 1.0 by 15% or more. The existing fish velocity setting was multiplied by this ratio to obtain the correct new setting. If adjustments were made to the sonar unit an additional calibration was made to ensure that the oscilloscope:sonar count ratio was within accepted limits, ±15%, and to initialize the counting period. Each calibration lasted for at least 15 min or until 100 salmon were counted by the observer, whichever was less.
Attempts were also made to visually enumerate fish passage from 3 m counting towers during sonar calibration times as a further check on sonar accuracy and to train operators in oscilloscope monitoring. Observers wore polaroid sunglasses to reduce water surface glare. Attempts to visually enumerate salmon during calibration times were discontinued from the west bank when it became apparent that the presence of the observer on the tower interfered with the normal passage of salmon past the sonar site. Salmon passed farther offshore when the observer was on the tower.

Four daily calibration times were deemed adequate to monitor the diel timing pattern of the salmon migration. Calibrations were normally conducted during 0600, 1200, 1800, and 2400 hours. However, during the initial and last days of the project when fish passage was low, calibrations were conducted during 0800, 1300, 1800, and 2400 hours.

Bank-specific calibration periods were defined by the time between individual calibrations on each bank. An associated adjustment factor, specific to each calibration period and to each bank was derived from the following formula:

$$A_{b,n}=\frac{(OC_{b,ts}+OC_{b,te})}{(SC_{b,ts}+SC_{b,te})}, \qquad (1)$$

where A = periodic adjustment factor,
b = west or east bank,
n = calibration period,
ts = time at start of calibration period ,
te = time at end of calibration period,
OC = oscilloscope counts, and
SC = sonar counts.

The periodic adjustment factor was applied to the unadjusted sonar counts for each hour within the associated calibration period for each bank. The resulting corrected sonar counts for each hour within a day were summed, yielding the estimated summer chum salmon passage for that day for that bank. Corrected hourly counts were calculated and totalled for each day and bank using a portable computer. The daily passage of salmon was determined by summing the daily bank estimates. Daily adjustment or correction factors for each bank and for both banks combined were calculated by dividing the daily corrected counts by the raw sonar counts. Raw sector counts for each day were corrected by using the overall daily correction factor. Corrected hourly and sector counts were used to determine the temporal and spatial distribution of the summer chum salmon run.

Sonar counters do not distinguish between species of salmon. However, a separate escapement estimate for chinook salmon was obtained by aerial survey. This count was not subtracted from the chum salmon sonar count because we assumed that most chinook salmon were not counted by the sonar counters. This assumption was based on tower observations which indicated that in most years, most chinook salmon migrated up the middle of the stream channel beyond the ensonified zones. Additionally, the relative small numbers of chinook salmon annually observed during aerial surveys conducted under fair or good conditions have averaged 0.3% of the estimated sonar counts of summer chum salmon escapement from 1979-1992. In 1993 chinook salmon observed during aerial survey flights may have accounted for a very small portion of the sonar count. The small numbers of chinook salmon that may have been counted as summer chum salmon during 1993 were considered insignificant.

During the 1993 season no pink salmon were observed from the observation tower, and they were not captured in beach seine samples for age,sex, and size sampling. Accordingly, pink salmon passage was estimated to be zero.

Missing hourly sector counts not recorded as a result of debris or printer malfunction were estimated by averaging the counts in the same sector for the hour before and after the count in question. When salmon were not counted for a large portion of a day, or a large portion of the counting range within a day, the corrected daily count total for that day was estimated by dividing the corrected partial daily count by the mean proportion of corrected counts for the corresponding hours or sectors for the first day before and after having full 24-hr counts. The estimated counts for the sectors or hours for which counts were not recorded were distributed by sector or hour based on the mean count-distribution pattern of the corresponding sectors or hours on the day before and day after. When counting was not conducted for a full day, the salmon passage estimate for that day was calculated as the mean salmon passage for the day before and after. The estimated daily counts were distributed by hour and sector based on the mean distribution pattern of corrected counts for the day before and after the missing count. When counting was not conducted for more than one full day, the passage estimate for those days was based on the mean proportion of east bank counts for the day before and after the period of missing counts. The estimated daily counts were distributed by hour and sector based on the mean distribution pattern of corrected counts for the day before and after the period of missing counts.

Age-Sex-Size Sampling

Season strata used for the comparison of hourly and sector passage data were defined by the early, early middle, late middle and late strata for age-sex-size sampling goals. Each terminal stratum was initially determined preseason based on historical run timing data; they represent an attempt to sample the escapement for age-sex-size information in relative proportion to the total run. Strata were defined as: 15 June-3 July; 4-8 July; 9-13 July; and 14-26 July. Unlike during the 1992 season, these strata were not adjusted inseason.

A beach seine (31 m long, 66 meshes deep, 6.35-cm mesh) was set approximately 100 m above the sonar site to capture chum and chinook salmon for age, sex, and size measurements. Chum and chinook salmon were placed in a holding pen, identified by sex, and measured in millimeters from mid-eye to fork-of-tail. One scale was taken for age determination from chum salmon. Scales were removed from an area posterior to the base of the dorsal fin and above the lateral line on the left side of the fish (Clutter and Whitesel 1956). The adipose fin was clipped on each fish before release to prevent resampling. Additionally, chinook salmon carcasses were sampled in August to supplement the beach seine sample. Three scales were taken from each chinook salmon sampled for determination of age and stock origin. Scale samples were later pressed on acetate cards and the resulting impressions viewed on a microfiche reader for age determination.

Sample size goals for each species were based on 95% precision with a 10% accuracy for each time stratum. A sample size of 138 fish per stratum (early, early middle, late middle, and late) was needed to describe the age composition of the chum salmon escapement by stratum (Bromaghin 1993). However, the sample size goal was increased to 152 per stratum to account for a 10% unageable rate. A sample size of 198 for the season (1 stratum) was needed to describe the age and sex composition of the chinook salmon escapement based on the number of expected age classes and an assumed 10% unageable rate (Bromaghin 1993). However, a sample size of 400 chinook salmon was deemed necessary for the scale pattern analysis baseline for the Anvik River chinook salmon stock (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication).

Hydrological and Climatological Sampling

A water depth profile was measured at 3-m intervals from established headpins across the width of the river by probing with a pole marked in 1-cm increments. Because the east bank sonar site was situated approximately 3 m upriver from the west bank site, one transect situated between the sites served to describe profile. Transect profile data were collected three times during the season.

Climatological data were collected at approximately 1800 hours each day at the campsite. Relative river depth was monitored by staff gauge marked in 0.01-ft increments. Change in water depth was converted to centimeters and presented as negative or positive increments from the initial reading of 0.0 cm. Water temperature was measured in degrees centigrade near shore at a depth of about 0.5 m. Daily maximum and minimum air temperatures were recorded in degrees centigrade. Subjective notes were kept by the crew describing wind speed and direction, cloud cover, and precipitation.

Run Timing

Since 1986, except for 1992, run timing of summer chum salmon within the Yukon River drainage was monitored at three locations: the lower Yukon River test fishery (rkm 32), Yukon sonar site (rkm 197), and Anvik River sonar site, located approximately 589 km from the mouth of the Yukon River (Figure 1). In 1992, the Yukon sonar project was conducted in an experimental mode, and complete timing statistics are not available.

Run timing statistics, quartile days, were calculated for chum salmon passage at the lower Yukon test fish, the Yukon sonar site, and Anvik sonar site for 1993 and compared. Because the Anvik River is the major producer of summer chum salmon in the Yukon River drainage, comparison of run timing statistics allowed a calculation of estimated migratory rate of the salmon between the lower Yukon test fishery and Yukon sonar site and the Anvik River sonar site.

RESULTS AND DISCUSSION

Sonar Assessment

Two sonar counters were operated on the Anvik River from 19 June through 27 July at the same sites used in previous years. Only a small portion of the central river channel, approximately 11 m, was not ensonified on 21 June (Figure 3). Because of decreasing river water level (Figure 4) and, consequently, cross-sectional area throughout the season, the central river channel not ensonified decreased to 4 m on 10 July and further decreased to 2 m on 24 July. Because sonar beam width and height increased with distance from the transducer, the ensonified zone also encompassed most of the vertical water column within the counting range.

The escapement count for the period 19 June through 27 July was 517,409 summer chum salmon (Table 1). Unlike the 1992 run, the 1993 Anvik River summer chum salmon passage did not vary substantially throughout the mid-portion of the run (Figure 5), but maintained relatively stable passage. Daily summer chum salmon passage between the first and third quartile days ranged from 12,183 to 28,977 chum salmon. Consequently, this relative low and stable daily passage during this period resulted in a very protracted mid-portion (Figure 6). The duration of the mid-50% portion of the 1993 run lasted 13 d, approximately 3 days longer than average and longer than all years except for 1991 (Table 2). In 1992 the mid-50% portion of the run took only 7 d to pass by the sonar site (Table 2), and was characterized by an obvious peak passage period (Figure 5).

In 1993 passage was greatest during the 7-d period, 12-18 July. This peak passage period included the median-day of passage, 12 July, and the third quartile day of passage, 18 July. During this 7-d period, 157,018 salmon, or 30% of the total season run, passed the sonar site. Highest daily passage proportion, 0.06, occurred on the median day of passage, 12 July (Table 1). Salmon were first counted passing the sonar site on 19 June, the earliest on record. However, this is more likely a function of initiation of project operations rather than summer chum salmon run timing. In most years, some salmon pass by the sonar site prior to and after project operations. However, these numbers are small and probably comprise less than 3 percent of the total run.

Buklis (1982a) expanded the season escapement estimates for 1972 through 1978, making it possible to more directly compare visual count estimates to more recent annual sonar count estimates (Figure 7). Assuming an average brood year contribution of 3% age-3, 59% age-4, 37% age-5, and 1% age-6 summer chum salmon, the 1993 escapement estimate of 517,409 summer chum salmon was 36% less than the weighted parent-year escapement from years 1987-1990 of 808,858 fish, and was 21% below the long-term (1972-1992) average of 650,926 fish.

A total of 39.87 h of sonar calibration were conducted over a 39-d period at the west bank site. West bank sonar accuracy (sonar count/oscilloscope count) averaged 1.07 (Table 3). Sonar accuracy averaged 1.09 for 38.87 h of oscilloscope calibration at the east bank site for a 38-day period (Table 3).

Buklis (1982b) first noticed a distinct diurnal salmon migration pattern during the 1981 season with a higher proportion of the salmon migration past the sonar site during the evening hours. A similar pattern was observed during the years 1985 through 1992 by Buklis (1985, 1986, 1987) and Sandone (1989, 1990a, 1990b, 1993, 1994). In 1993 temporal distribution of the west (Appendix A) and east (Appendix B) bank adjusted sonar counts by hour also indicated a distinct diel pattern of salmon passage (Figure 8). Based upon adjusted counts, salmon passage was lowest, less than 4.0% of the total passage, from 1200 to 2100 hours (averaging 3.4% of total daily passage per hour) and greatest, greater than 5.0% of the total passage, from 0200-0600 (averaging 5.4% of total daily passage per hour). Chum salmon passage between the hours of 6000 and 1200 was intermediate, averaging 4.4% of the total daily passage per hour. This pattern was relatively consistent throughout the season (Figure 9) and similar to the historical temporal distribution pattern of the migration.

In all but one year that sonar was used to estimate Anvik River summer chum salmon escapement, a majority of the escapement passage has been associated with the west bank (Mauney and Buklis 1980; Buklis 1981, 1982b, 1983, 1984a, 1984b, 1985, 1986, 1987; Sandone 1989, 1990a, 1990b, 1993, 1994). In 1992 only 43% of the total adjusted counts were observed on the west bank (Sandone 1994). This percentage was very dissimilar to the historical average, and was attributed to the salmon following the edge of a shallow offshore bar, or shelf, which extended downstream of the east bank sonar site in conjunction with low water levels (Sandone 1993). Because of the salmon migrating along the offshore edge of this bar, a substantial number of salmon also travelled much farther offshore than in previous years (Sandone 1993). In 1993, however, this bar was not well defined, which probably resulted in a more normal salmon migration. In 1993 approximately 74% of the chum salmon migrated along the west shore. The 1985-92 average percent of adjusted counts of salmon which migrated along the west bank is 70%. Additionally, as in previous years, we assumed that only a very small portion of the total summer chum salmon passage was not counted during the operational period. This assumption was especially plausible in 1993 considering the very low water levels encountered.

Salmon passage along the west bank (Figure 8) was greatest in near-shore sector 2, 20.9%, and decreased in sectors farther offshore and onshore (Appendix C). Sectors 1 through 6 accounted for 66.0% of the total chum salmon passage and 86.8% of the west bank passage estimate. This distribution of salmon passage along the west bank was very similar to previous years. Chum salmon passage along the east bank (Figure 8) did not exhibit the anomalous pattern observed during the 1992 migration, but was very similar to migration patterns observed for years prior to 1992. In these years, near-shore sectors accounted for the majority of the passage along the east bank. In 1993, near shore sectors 29 -32 accounted for 18.3% of the total 1993 passage and 76.5% of the total east bank passage estimate. Distribution among the 3 east bank near-shore sectors, 30-32 was very similar (Figure 8). Together, near-shore sectors 1-4 and 29-32 accounted for 85.4% of the total estimated 1993 summer chum salmon passage. The remaining 14.6% passage was distributed over the remaining 21 sectors (Figure 8).

Except for the first stratum, the proportion of fish passing along the east bank increased as the run progressed. This shift is consistent with migration patterns observed in 1990 and 1991 (Sandone 1990b; 1993). During 1992, however, the opposite shift was observed. The 1992 summer chum migration shifted from a dominate east-bank to west bank migration (Sandone 1994). In 1993, percent salmon passage along the east bank during the second stratum was 5%; percent passage increased to 24.6% during the third stratum; and further increased to 34.5% during the final stratum. In 1993 percent passage along the east bank was relatively high during the first sampling stratum, accounting for 16.5% of the total stratum passage. However, most of this passage occurred when a relatively large number of counts, 5,795, were recorded in the early morning hours of 21 June (Appendix B), primarily in the extreme offshore sector, sector 17 (Appendix D). The raw counts were originally suspected to be debris counts caused by the sonar beam reflecting off the bottom or surface of the water. However, after reviewing the data collected, in conjunction with review of transducer aim and placement, we concluded that these counts were probably associated with a relatively large pulse of fish which was travelling offshore.

Throughout the season, salmon passage along the west bank shifted from extreme onshore to sectors farther offshore (Figure 10). This passage shift was probably caused by fish avoiding the transducer and weir in conjunction with decreasing water levels. A shift in the spatial migration pattern did not occur on the east bank, although such a shift may first seem apparent in the sector-distribution data. Passage along the east bank appeared to change from predominantly offshore, in sectors 25-29, during the first two sampling stratum, to on-shore during the third and fourth sampling stratum. This apparent shift in migration pattern was caused by moving the transducer farther offshore as water levels decreased, and not by a shift in the spatial migration pattern of the salmon.

Lower Yukon test net CPUE indicated that the 1993 Yukon River summer chum salmon run was below average in abundance. The Yukon River mainstem sonar passage estimate of 947,190 summer chum salmon (S. Fleischman, Alaska Department of Fish and Game, Anchorage, personal communication) indicated that the run was poor. Because of these poor run strength indicators only one restricted mesh size fishing period was scheduled in District 1. No other restricted mesh size fishing period was scheduled in the Lower Yukon Area. Additionally, because of the below average run, and the desire to protect the Andreafsky River and other less abundant upriver summer chum salmon stocks, commercial fishing in the Lower Yukon Area was concluded on 1 July. The 1993 commercial harvest of 95,323 summer chum salmon in the lower Yukon River fisheries was only 37% of the low end of the combined Lower Yukon Area guideline harvest range of 257,000. The high end of the range is 774,000 salmon.

Inseason Anvik River passage estimates in conjunction with the Yukon sonar passage estimates also played a major role in the management of the Upper Yukon Area fisheries in 1993. Passage data from these projects were used to assess summer chum salmon run size above the confluence of the Anvik and Yukon Rivers. Although the minimum escapement goal of 500,000 salmon for the Anvik River was met, there was serious concern that escapement to tributary streams above the Pilot Station sonar site, other than the Anvik River, would not be met without severe restrictions to Upper Yukon Area fishing schedules. Consequently, only two fishing periods were scheduled in Subdistrict 4A for a total fishing time of 21 hours. During these two periods approximately 38,196 summer chum salmon were harvested to produce the 20,485 pounds of summer chum salmon roe sold. The 21 hours of commercial fishing time allowed in Subdistrict 4A was only 22% of the fishing time allowed during the 1992 season and only 4% of the normal fishing schedule, which last occurred during the 1986 season. Consequently, the 1993 commercial harvest of 38,196 summer chum salmon in the Subdistrict 4A fishery was only 34% of the low end of the guideline harvest range of 113,000 salmon. The high end of the range is 338,000 salmon. Similar reductions in scheduled commercial fishing time resulted in associated low commercial harvests of summer chum salmon in other Upper Yukon Area districts as well (Schultz et al. 1993).

Based on a Yukon sonar passage estimate of 947,192 summer chum salmon, approximately

329,047 salmon escaped to tributaries above the sonar site other than the Anvik River. As in most other years summer chum salmon escapement to various tributaries above the Anvik River was assessed by aerial survey. Aerial survey counts of summer chum salmon escapements to North Fork Nulato River and Salcha River were only 15% and 6%, respectively, of the established escapement goal (Table 4). Escapement surveys of the two other tributaries which have established escapement goals, Clear and Caribou Creeks of the Hogatza River, were not conducted during 1993. Aerial surveys of other tributaries which do have an established escapement goal (Table 4) indicated that summer chum salmon escapement was well below the long-term average and was considered poor in every case.

Age and Sex Composition

Summer Chum Salmon

Beach seine sets were made from 29 June to 23 July on 14 individual days. In all but the first sampling day only 1 set was made. On 29 June, because of the few fish present, 4 sets were made. A total of 660 chum salmon were captured (Appendix E). No chinook or pink salmon were captured (Appendix E). Stratum sampling sizes for summer chum salmon were 160, 161, 161, and 178 for the four sampling strata. The sampling goal of 138 ageable scales per stratum was achieved for the first and final strata. Ageable scales totaled 128, or 93% of the sampling goal, for the second stratum, and 127, or 92% of the sampling goal, for the third stratum. Overall, of the 660 chum salmon sampled for age-sex-size data, (83%) had ageable scales. The 1993 percentage of ageable scales is much lower than expected, 90%, and much lower than observed in previous years. In 1993 a higher percentage than normal of reabsorbed, regenerated, illegible, and inverted scales were observed in the sample (J. Menard, Alaska Department of Fish and Game, Anchorage, personal communication).

Sample sizes have been sufficient since 1989 to examine sex and age composition by sampling stratum. In all years, age and sex of the escapement passing the sonar site has varied through the duration of the run. As in other years since 1989, the same general pattern of an increasing proportion of younger, female salmon was observed during the 1993 run (Figure 11). In 1993 age-4 chum salmon dominated every sampling stratum (Figure 11). Additionally, proportion of age-4 salmon increased from 51% during the first stratum to 72% in the final stratum, whereas age-5 and age-6 salmon decreased (Figure 11). Age composition of the escapement weighted by strata escapement counts was 0.6% age 3, 64.8% age 4, 32.4% age 5, and 2.2% age 6 (Appendix F). Age-4 chum salmon dominated the escapement in 15 of the 22 years of record. Age-5 chum salmon dominated the escapement in 1972, 1976, 1981, 1986, 1989, 1991 and 1992 (Figure 12). The contribution of age-4 salmon, 64.8%, was above the long-term (1972-1992) average contribution of age-4 salmon to the escapement, 59.4%. Conversely, the contribution of age-5 was the below the long-term average contribution of age-5 salmon to the escapement, 36.5%. The contribution of age-6 salmon was the more than double the long-term average contribution of 0.9% whereas the contribution of age-3 salmon was well below the long-term average contribution of 3.2% (Appendix F).

Although an average to below average summer chum salmon run was expected for the Yukon River in 1993 (ADF&G 1993), the run materialized even weaker than projected. With the exception of the Anvik River, spawning escapements (Table 4) were extremely poor throughout the Yukon River drainage. The minimum escapement goal was met in the Anvik River because the directed summer chum salmon commercial fishery in the Lower Yukon Area was severely restricted. Although that age-4 salmon dominated the Anvik River escapement, the poor return indicated that, as in 1992 (Sandone 1994), production from the parent year of the age-4 salmon was disappointingly low. Unexpectedly low production has been documented for four of the last five returning brood years, 1985 (Sandone 1990a), 1986 (Sandone 1990b), 1988 (Sandone 1993), and 1989.

In 1993 female chum salmon accounted for 52.0% of the 1993 escapement to the Anvik River. Females have contributed more than 50% to the escapement sample of summer chum salmon in 19 of the 22 years of record (Appendix F). Overall, the female contribution has ranged from 39.1% in 1974 to 69.4% in 1982. Similar to recent years (Sandone 1990a, 1990b, 1993, 1994), the female component of the 1993 Anvik River escapement increased as the run progressed. In prior years, male chum salmon usually dominated at least the first sampling stratum whereas, female salmon dominated at least the final two strata. In 1993, male salmon dominated the first stratum; female salmon dominated the last two strata (Figure 11). Near equal percentages were observed within the second sampling stratum.

Generally, in previous years age class compositions of both the Anvik River escapement and the District 1 summer chum salmon commercial harvest have been very similar (Figure 13). However, as in 1990 (Sandone 1990b), the age composition of the Anvik River escapement and the District 1 commercial harvest were dissimilar. Although both escapement and harvest samples contained few age-3 and age-6 salmon, the escapement was dominated by the age-4 component whereas the harvest was dominated by the age-5 component. The preliminary age-class composition estimate of the total District 1 summer chum salmon harvest was 0.0% age 3, 41.7% age 4, 53.1% age 5, and 4.9% age 6 (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). Generally, male salmon dominated the District 1 commercial harvest, whereas female salmon dominated the Anvik River escapement. However, in 1993 near equal percentages of male and female salmon were harvested in the District 1 commercial harvest and escaped to the Anvik River spawning grounds. The size-selectivity of gillnets used in the District 1 commercial fishery, in conjunction with the timing of the fishing periods may have contributed to these anomalies.

Chinook Salmon

No chinook salmon were captured by beach seine. However, 406 chinook salmon carcass samples were collected by boat survey in August. Of the Anvik River chinook salmon sampled for age-sex-size data, 340 (84%) provided ageable scales. Age composition was 13.8% age 4, 38.5% age 5, 45.6% age 6, and 2.1% age 7 (Figure 15). Females accounted for 42.1% of the sample (Appendix G), slightly greater than the 40.2% long-term average (1972-1992 excluding 1974 when no samples were obtained).

Age composition of the District 1 commercial harvest was approximately 5.5% age 4, 21.3% age 5, 63.8% age 6, and 9.3% age 7. Female chinook salmon accounted for 48.7% of the harvest (D. Schneiderhan, Alaska Department of Fish and Game, Anchorage, personal communication). Generally, the District 1 commercial catch and Anvik River escapement age composition samples of chinook salmon are quite dissimilar (Figure 16). Anvik River escapement has been composed of younger-aged salmon than the District 1 commercial harvest (Figure 16). This difference was also observed in 1993. This difference is most likely due to the differences in age compositions and run strengths of the various chinook stocks present in the lower river during the harvest period and secondarily to the size-selective nature of the commercial gillnets.

An aerial survey of the Anvik River, from Goblet Creek to McDonald Creek, and Beaver Creek, was flown on 23 July under fair to poor survey conditions. A total of 1,720 chinook salmon were enumerated. The count of 1,525 chinook salmon in the mainstem Anvik River between the Yellow River and McDonald Creek (Figure 2) was three times the minimum escapement goal of 500 chinook salmon for this index area.

Hydrologic and Climatological Sampling

River transect data collected on 21 June, 10 July, and 24 July indicates that the bottom gradient was relatively smooth on both banks and free of major obstructions to the sonar beam (Figure 3). River width data collected in conjunction with the transect profiles varied from a high of approximately 69 m on 21 June to a low of 53 m on 24 July. Maximum depth, and probably maximum river width, occurred on the first full day of field operations, 19 June (Appendix H). River water level dropped approximately 84.1 cm between 19 June and 26 July (Figure 4). River water level dropped in a consistent and regular manner throughout the season. This general trend in decreasing river level was only slightly interrupted two or three times during the season (Figure 4).

Instantaneous water temperature ranged from a low of 11° C recorded on 8 July to a high of 20° C recorded on 21 and 22 July. Because of equipment malfunction, daily minimum air temperatures were available only from 3 July to 26 July. During this time daily minimum and maximum air temperatures ranged from a minimum low of 7° C, observed on 5 July, to a maximum high of 37° C, observed on 21 July (Figure 4). Although the daily minimum low air temperature probably occurred prior to 3 July, during the time when minimum temperatures were not recorded, the maximum air temperature did not (Figure 4).

Run Timing

Similar to the 1990 run, number of days between the first and third quartile passage days, the mid-50% of the run passage, were approximately 3 d longer in duration than the long-term average (Table 2), indicating that salmon passage was more spread out over the duration of the run than normal. Runs with higher than average passage days for the mid-50% of the run usually exhibit bi-modality in the daily salmon passage, or exhibit an extended period of relatively low, stable passage. Of the six years which the mid-50% of the run lasted more than 10 days, three exhibited obvious bi-modality, 1983, 1987, and 1991, whereas the remaining three years, 1989, 1990 and 1993 exhibited more protracted but consistent passage (Figure 5). However, the 1989 and 1990 run also exhibited weak bi-modality.

Although the day on which the first salmon was counted was the earliest on record (Table 2), the first quartile day of passage, 5 July, was 2 d later than average (Table 2). Because of the passage pattern of relatively low, stable daily passage numbers, the remaining timing statistics were even later than average. The median day of passage, 12 July, was 4 d later than average (Table 2); the third quartile day of passage, 18 July, the latest on record, was 5 d later than average (Table 2).

Summer chum salmon run timing at the lower Yukon River set gillnet test fishery (rkm 32), at the Yukon River sonar site (rkm 197), and at the Anvik River sonar site located 589 km from the mouth of the Yukon River (Figure 1), were compared to provide a qualitative assessment of summer chum salmon migration through the lower river fisheries (Figure 17). In 1993, 55% of the estimated summer chum salmon which passed the mainstem Yukon River sonar site also passed the Anvik River sonar site. Although there is a major spawning tributary, the Andreafsky River (Figure 1), between the lower Yukon River test fishery and the mainstem Yukon River sonar site, it has been assumed that most of the unharvested salmon migrating past the lower Yukon River test fishing sites also pass the Yukon River sonar site. This assumption was probably met because of the relative difference in magnitude between the Andreafsky River summer chum salmon stock and all other summer chum salmon stocks passing upstream of the Yukon River sonar site. During the years 1981-1988, when sonar or tower counts of summer chum salmon escapement were available for the East Fork Andreafsky River, excluding 1985 (Table 4), escapement to the Anvik River alone was, on the average, approximately 9 times greater than the East Fork Andreafsky River escapement (range = 2.5 - 16.3). Because aerial survey escapement goals for the East (109,000 salmon) and West (116,000 salmon) Fork Andreafsky River are very similar, it was also assumed that a substantial portion, up to 50%, of the total Andreafsky River escapement was represented by the East Fork for these years. Therefore, during this time, summer chum salmon escapement to the Anvik River alone probably averaged more than 4 times the Andreafsky River escapement. The 1993 aerial survey counts of summer chum salmon escapement to the both forks of the Andreafsky River, 20,046, was considered poor; escapement to the Anvik River of 517,409, slightly exceeded the minimum escapement goal of 500,000. Therefore, we believe that in 1993 most of the unharvested salmon migrating past the lower Yukon test fishing sites also passed the Yukon River and Anvik River sonar sites.

Because we assume that a majority of the summer chum salmon pass all three sites, we can subjectively assess run timing of the summer chum salmon run between these sites. The median date of the 1993 summer chum salmon passage was 26 June at the lower river test fishing sites, 4 July at the Yukon River sonar site, and 12 July at the Anvik River sonar site. Based on these data, the difference, or lag time, between the lower river test fishery and the Anvik River sonar site in 1993 was 16 d (1986-92 average = 14.9 d, SE=3.6), whereas the lag time between the Yukon River and Anvik River sonar sites was 8 d (1986-1991 average = 9.5 d, SE = 1.6). Based on distance and time between median days of passage, the calculated swimming speed of summer chum salmon in 1993 was approximately 35 km/d from the lower river test fishery to the Anvik River sonar site, and 49 km/d between the two sonar sites. Average swimming speed, based on similar calculations, between the lower Yukon River test fishing sites and the Anvik River sonar site was 40 km/d (1986-1992 average), and 42 km/d (1986-1991 average) between the two sonar sites. These calculations, however, may be affected by fluctuations in test net efficiency and sonar accuracy, and differences in run strengths and run timing of the various summer chum salmon stocks of the Yukon River drainage.

Inspection of the daily test fishing catch per unit effort in the lower river test fishery, Yukon River sonar counts, and Anvik River sonar counts does not indicate the degree of comparability as in previous years. Although lower Yukon test fish CPUE corresponds well with Yukon sonar counts from 15 June through 3 July, the comparison before and after that period does not (Figure 17). Comparison between the Yukon sonar and Anvik sonar counts appear to be, for the most part, unrelated (Figure 17). However, it is interesting that the quartile days of passage for all projects appear to compare fairly well with the assumed 3 d lag between lower Yukon test fishery and Yukon sonar and a 10 lag between Yukon sonar and Anvik sonar counts (Figure 17). As in the fish swimming speed calculations among projects, these comparisons may be affected by fluctuations in test net efficiency and sonar accuracy, and varying run strength and timing differences of the various summer chum salmon stocks of the Yukon River drainage.

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Table 1. Anvik River summer chum salmon sonar counts by date, 1993.

	West Bank				East Bank				Entire River				
Date	Raw Daily Count	Adjust Factor[a]	Corrected Daily Count	Percentage of Daily Total	Raw Daily Count	Adjust Factor[a]	Corrected Daily Count	Percentage of Daily Total	Raw Daily Count	Corrected Daily Count	Corrected Season Count	Daily Prop.	Season Prop.
19–Jun	324 [b]	0.57	185	100.0	–	–	–	0.0	324	185	185	0.00	0.00
20–Jun	1,445	0.74	1,063	99.5	7 [c]	0.71	5	0.5	1,452	1,068	1,253	0.00	0.00
21–Jun	5,102	0.86	4,406	41.5	8,013	0.77	6,200	58.5	13,115	10,606	11,859	0.02	0.02
22–Jun	6,067	0.84	5,105	91.8	468	0.98	459	8.2	6,535	5,564	17,423	0.01	0.03
23–Jun	5,039	1.03	5,203	97.3	159	0.91	145	2.7	5,198	5,348	22,771	0.01	0.04
24–Jun	1,709	0.92	1,573	70.2	728	0.92	667	29.8	2,437	2,240	25,011	0.00	0.05
25–Jun	1,216	0.84	1,023	84.2	– [d]	–	192 [f]	15.8	1,216	1,215	26,226	0.00	0.05
26–Jun	4,127	1.00	4,139	84.2	– [d]	–	777 [f]	15.8	4,127	4,916	31,142	0.01	0.06
27–Jun	4,648	0.90	4,185	84.2	– [d]	–	784 [f]	15.8	4,648	4,969	36,111	0.01	0.07
28–Jun	3,113	1.00	3,119	84.2	– [d]	–	584 [f]	15.8	3,113	3,703	39,814	0.01	0.08
29–Jun	2,249	0.95	2,147	98.2	40	0.98	39	1.8	2,289	2,186	42,000	0.00	0.08
30–Jun	4,738	1.06	5,012	94.5	291	1.00	290	5.5	5,029	5,302	47,302	0.01	0.09
01–Jul	9,573	0.97	9,299	82.3	2,069	0.96	1,995	17.7	11,642	11,294	58,596	0.02	0.11
02–Jul	18,304	0.90	16,417	95.2	647	1.28	830	4.8	18,951	17,247	75,843	0.03	0.15
03–Jul	11,771	1.07	12,627	86.4	774	2.58	1,995	13.6	12,545	14,622	90,465	0.03	0.17
04–Jul	19,532	1.04	20,401	94.7	810	1.42	1,147	5.3	20,342	21,548	112,013	0.04	0.22
05–Jul	28,513	0.65	18,617	94.1	1,120	1.04	1,165	5.9	29,633	19,782	131,795	0.04	0.25
06–Jul	19,359	0.90	17,519	95.3	767	1.12	861	4.7	20,126	18,380	150,175	0.04	0.29
07–Jul	22,729	0.94	21,260	97.3	477	1.25	596	2.7	23,206	21,856	172,031	0.04	0.33
08–Jul	12,605	0.89	11,225	92.1	1,013	0.95	958	7.9	13,618	12,183	184,214	0.02	0.36
09–Jul	16,585	0.95	15,709	92.3	1,436	0.91	1,309	7.7	18,021	17,018	201,232	0.03	0.39
10–Jul	26,258	0.93	24,530	92.0	– [d]	–	2,137 [g]	8.0	26,258	26,667	227,899	0.05	0.44
11–Jul	19,220	0.94	18,007	85.9	3,115	0.95	2,955	14.1	22,335	20,962	248,861	0.04	0.48
12–Jul	15,546	0.96	14,898	51.4	17,461	0.81	14,079	48.6	33,007	28,977	277,838	0.06	0.54
13–Jul	13,611	0.97	13,226	63.1	10,893	0.71	7,726	36.9	24,504	20,952	298,790	0.04	0.58
14–Jul	13,749	0.97	13,287	78.7	4,064	0.88	3,591	21.3	17,813	16,878	315,668	0.03	0.61
15–Jul	15,978	1.01	16,131	81.2	4,423	0.84	3,728	18.8	20,401	19,859	335,527	0.04	0.65
16–Jul	13,423	1.00	13,459	72.0	5,599	0.93	5,233	28.0	19,022	18,692	354,219	0.04	0.68
17–Jul	16,185	1.04	16,857	67.0	8,470	0.98	8,295	33.0	24,655	25,152	379,371	0.05	0.73
18–Jul	16,417	0.98	16,040	60.5	9,454	1.11	10,468	39.5	25,871	26,508	405,879	0.05	0.78
19–Jul	11,700	1.03	12,064	56.5	9,010	1.03	9,275	43.5	20,710	21,339	427,218	0.04	0.83
20–Jul	13,569	0.97	13,122	58.1	9,770	0.97	9,451	41.9	23,339	22,573	449,791	0.04	0.87
21–Jul	11,229	0.99	11,122	57.0	8,669	0.97	8,388	43.0	19,898	19,510	469,301	0.04	0.91
22–Jul	7,422	0.87	6,451	56.8	5,448	0.90	4,900	43.2	12,870	11,351	480,652	0.02	0.93
23–Jul	4,559	0.96	4,375	64.5	2,502	0.96	2,404	35.5	7,061	6,779	487,431	0.01	0.94
24–Jul	4,439	0.88	3,890	65.9	2,287	0.88	2,013	34.1	6,726	5,903	493,334	0.01	0.95
25–Jul	6,817	1.00	6,803	74.1	2,468	0.97	2,384	25.9	9,285	9,187	502,521	0.02	0.97
26–Jul	6,087	0.89	5,401	66.9	2,750	0.97	2,675	33.1	8,837	8,076	510,597	0.02	0.99
27–Jul	5,204	0.79	4,096	60.1	3,250	0.84	2,716	39.9	8,454	6,812	517,409	0.01	1.00
Total	420,159		393,993		128,451		123,416		548,611	517,409			
Mean		0.93		78.8		0.86		21.2					
Season adjust. factor[h]		0.94				0.96			0.94				

[a] Adjustment factor is the proportion of corrected daily sonar counts to the raw sonar counts.
[b] Counts initiated on west bank on 19 June at 1500 hours.
[c] Counts initiated on east bank on 20 June at 1700 hours.
[d] Daily count unavailabe.
[f] Counts based on the mean proportion of east bank counts on 24 and 29 June.
[g] Counts based on mean number of east bank counts on 9 and 11 July.
[h] Season adjustment factor is the proportion of corrected season sonar counts to the unadjusted sonar counts.

Table 2. Annual Anvik River sonar passage estimates and associated passage timing statistics of the summer chum salmon run, 1979–1993.

Year	Sonar Passage Esitmate	Day of First Salmon Counts	First Quartile Day	Median Day	Third Quartile Day	Days Between Quartile Days First & Median	Median & Third	First & Third
1979	277,712	23–Jun	02–Jul	08–Jul	12–Jul	6	4	10
1980	482,181	28–Jun	06–Jul	11–Jul	16–Jul	5	5	10
1981	1,479,582	20–Jun	27–Jun	02–Jul	07–Jul	5	5	10
1982	444,581	25–Jun	07–Jul	11–Jul	14–Jul	4	3	7
1983	362,912	21–Jun	30–Jun	07–Jul	12–Jul	7	5	12
1984	891,028	22–Jun	05–Jul	09–Jul	13–Jul	4	4	8
1985	1,080,243	05–Jul	10–Jul	13–Jul	16–Jul	3	3	6
1986	1,085,750	21–Jun	29–Jun	02–Jul	06–Jul	3	4	7
1987	455,876	21–Jun	05–Jul	12–Jul	16–Jul	7	4	11
1988	1,125,449	21–Jun	30–Jun	03–Jul	09–Jul	3	6	9
1989	636,906	20–Jun	01–Jul	07–Jul	13–Jul	6	6	12
1990	403,627	22–Jun	02–Jul	07–Jul	15–Jul	5	8	13
1991	847,772	21–Jun	01–Jul	10–Jul	16–Jul	9	6	15
1992	775,626	29–Jun	05–Jul	08–Jul	12–Jul	3	4	7
1993	517,409	19–Jun	05–Jul	12–Jul	18–Jul	7	6	13
Mean[a]	739,232 [b]	23–Jun	03–Jul	08–Jul	13–Jul	5.2	4.8	10.0
SE[a]	359,561 [b]	4.5	3.5	3.3	2.8	1.8	1.4	2.6

[a] The mean and SE of the timing statistics includes estimates from years 1979–1985 and 1987–1992. In 1986 sonar passage counting was terminated early, probably resulting in the incorrect calculation of the quartile days. Therefore, 1986 run timing statistics were excluded from the calculation of the overall mean and SE.

[b] Includes 1986 passage data.

23–Sep–94:SSONVIK.WK3

Table 3. Sonar and corresponding oscilloscope counts of salmon at the Anvik River west and east bank sonar sites, 1993.

Date	West Bank Sonar Site: Elapsed Time (hrs:min)	Sonar Count	Scope Count	Sonar/ Scope	East Bank Sonar Site: Elapsed Time (hrs:min)	Sonar Count	Scope Count	Sonar/ Scope
19-Jun	00:15	1	3	0.33	00:00			
20-Jun	01:16	36	26	1.38	00:15	1	1	1.00
21-Jun	01:06	225	184	1.22	00:56	87	83	1.05
22-Jun	00:50	172	159	1.08	01:15	78	91	0.86
23-Jun	00:39	38	39	0.97	01:15	2	2	1.00
24-Jun	01:06	90	86	1.05	01:15	9	8	1.13
25-Jun	01:35	134	109	1.23	00:00			
26-Jun	01:17	185	186	0.99	00:00			
27-Jun	01:31	245	215	1.14	00:15	0	0	
28-Jun	01:00	109	110	0.99	00:31	0	0	
29-Jun	00:50	168	160	1.05	00:45	1	1	1.00
30-Jun	00:43	103	116	0.89	00:30	22	25	0.88
01-Jul	01:50	751	648	1.16	01:15	69	59	1.17
02-Jul	01:32	679	663	1.02	01:45	28	47	0.60
03-Jul	00:56	561	547	1.03	01:01	18	37	0.49
04-Jul	01:36	684	608	1.13	01:15	33	40	0.83
05-Jul	00:21	247	190	1.30	00:15	5	4	1.25
06-Jul	01:18	588	572	1.03	00:45	33	42	0.79
07-Jul	00:50	423	399	1.06	01:45	85	69	1.23
08-Jul	00:50	492	416	1.18	01:00	85	78	1.09
09-Jul	00:39	416	388	1.07	01:15	64	58	1.10
10-Jul	00:52	432	405	1.07	01:16	324	285	1.14
11-Jul	00:47	541	503	1.08	01:30	167	167	1.00
12-Jul	00:37	288	280	1.03	01:19	720	575	1.25
13-Jul	01:05	493	466	1.06	01:39	453	325	1.39
14-Jul	00:57	379	363	1.04	01:26	155	142	1.09
15-Jul	00:50	378	379	1.00	01:15	171	141	1.21
16-Jul	01:20	570	575	0.99	01:30	221	202	1.09
17-Jul	00:46	472	504	0.94	01:05	387	388	1.00
18-Jul	01:01	510	490	1.04	00:52	184	195	0.94
19-Jul	00:35	307	296	1.04	01:18	456	481	0.95
20-Jul	01:06	585	605	0.97	01:00	231	211	1.09
21-Jul	00:37	247	245	1.01	01:14	303	292	1.04
22-Jul	00:55	313	271	1.15	01:00	152	135	1.13
23-Jul	01:02	236	226	1.04	01:00	98	88	1.11
24-Jul	01:00	179	159	1.13	01:15	99	88	1.13
25-Jul	01:00	303	308	0.98	01:00	87	83	1.05
26-Jul	01:15	434	374	1.16	01:00	68	67	1.01
27-Jul	01:37	407	325	1.25	01:00	163	132	1.23
Total	39:52	13,421	12,598	1.07	38:52	5,059	4,642	1.09

Table 4. Summer chum salmon escapement counts for selected spawning areas in the Yukon River drainage, 1973–1993.

Year	Andreafsky River[a] East Fork Aerial	Andreafsky River[a] East Fork Sonar or Tower	Andreafsky River[a] West Fork	Anvik River[a] Tower & Aerial[b]	Anvik River[a] Sonar	Rodo River[a]	Nulato River[a] South Fork	Nulato River[a] North Fork[c]	Gisasa River[a]	Hogatza River[a] (Clear and Caribou Crs)	Tozitna River[a]	Chena River[a]	Salcha River[a]
1973	10,149 [d]		51,835	86,665 [d]								79 [d]	290
1974	3,215 [d]		33,578	201,277		16,137	29,016	29,334	22,022		1,823	4,349	3,510
1975	223,485		235,954	845,485		25,335	51,215	87,280	56,904	22,355	3,512	1,670	7,573
1976	105,347		118,420	406,166		38,258	9,230 [d]	30,771	21,342	20,744	725 [d]	685	6,484
1977	112,722		63,120	262,854		16,118	11,385	58,275	2,204 [d]	10,734	761 [d]	610	677 [d]
1978	127,050		57,321	251,339		17,845	12,821	41,659	9,280 [d]	5,102	2,262	1,609	5,405
1979	66,471		43,391	81,830 [d]	280,537		1,506	35,598	10,962	14,221		1,025 [d]	3,060
1980	36,823 [d]		114,759		492,676		3,702 [d]	11,244 [d]	10,388	19,786	580	338	4,140
1981	81,555	147,312 [g]			1,486,182		14,348					3,500	8,500
1982	7,501 [d]	181,352 [g]	7,267 [d]		444,581				334 [d]	4,984 [d]	874	1,509	3,756
1983		110,608 [g]			362,912		1,263 [d]	19,749	2,356 [d]	28,141	1,604	1,097	716 [d]
1984	95,200 [d]	70,125 [g]	238,565		891,028					184 [d]		1,861	9,810
1985	66,146		52,750		1,080,243	24,576	10,494	19,344	13,232	22,566	1,030	1,005	3,178
1986	83,931	167,614 [h]	99,373		1,189,602		16,848	47,417	12,114		1,778	1,509	8,028
1987	6,687 [d]	45,221 [h]	35,535		455,876		4,094	7,163	2,123	5,669 [d]		333	3,657
1988	43,056	68,937 [h]	45,432		1,125,449	13,872	15,132	26,951	9,284	6,890	2,983	432	2,889 [d]
1989	21,460 [d]				636,906							714 [d]	1,574 [d]
1990	11,519 [d]		20,426 [d]		403,627	1,941 [d]	3,196 [d,j]	1,419 [d]	450 [d]	2,177 [d]	36	245 [d]	450 [d]
1991	31,886		46,657		847,772	3,977	13,150	12,491	7,003	9,947	93	115 [d]	154 [d]
1992	11,308 [d]		37,808 [d]		775,626	4,465	5,322	12,358	9,300	2,986	794	848 [d]	3,222
1993 [r]	10,935 [d]		9,111 [d]		517,409	7,867	5,486	7,698	1,581		970	168	212
E.O.[k]	>109,000		>116,000		>500,000 [m]	15,490	12,248	>53,000 [p]	11,228	>17,000 [p]	1,322	1,129	>3,500

[a] Data obtained by aerial survey unless otherwise noted. Only peak counts are listed. Latest table revision January 11, 1994.
[b] From 1972–1979, counting tower operated; mainstem aerial survey counts below the tower were added to tower counts.
[c] Includes mainstem counts below the confluence of the North and South Forks, unless otherwise noted.
[d] Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.
[f] Boat survey
[g] Sonar count.
[h] Tower count.
[j] Mainstem counts below the confluence of the North and South Forks Nulato River included in the South Fork counts.
[k] Interim escapement objective.
[m] The Anvik River Escapement Objective was rounded upward to 500,000 from 487,000 in March, 1992.
[n] Interim escapement objective for North Fork Nulato River only.
[p] Consists of Clear and Caribou Creeks interim escapement objectives of 9,000 and 8,000, respectively.
[r] Preliminary.

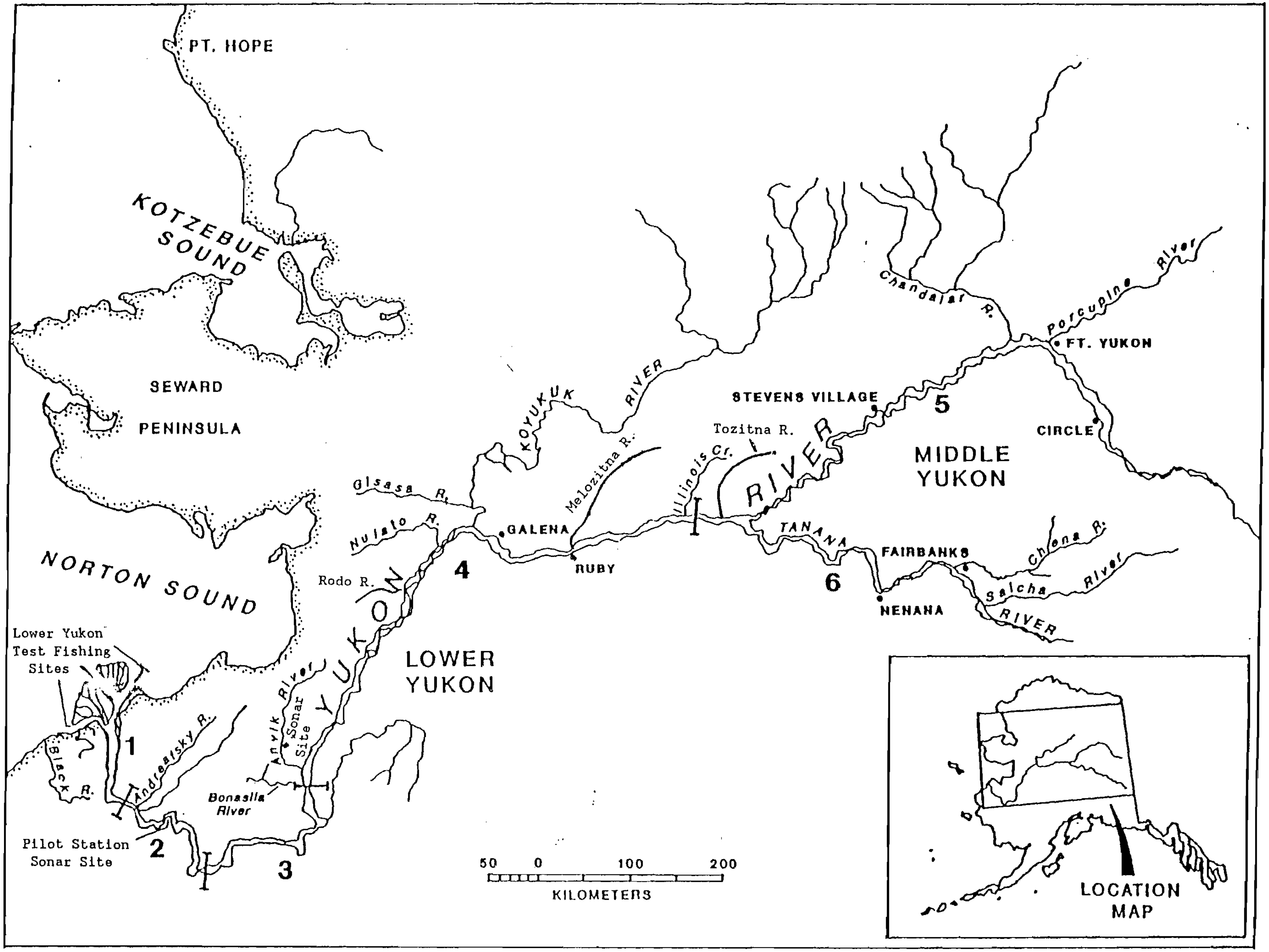

Figure 1. Alaskan portion of the Yukon River showing fishing district boundaries.

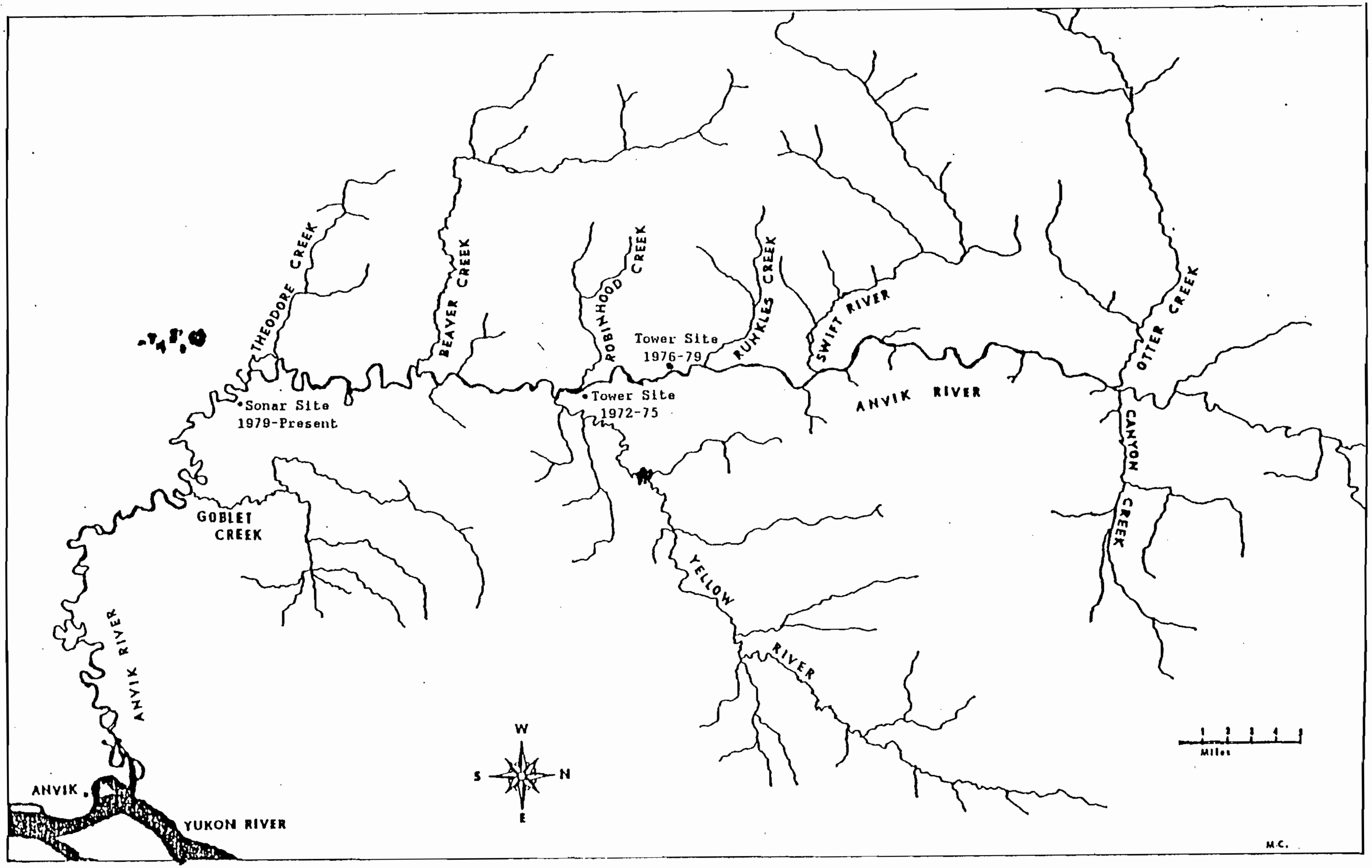

Figure 2. The Anvik River drainage showing sonar and counting tower sites.

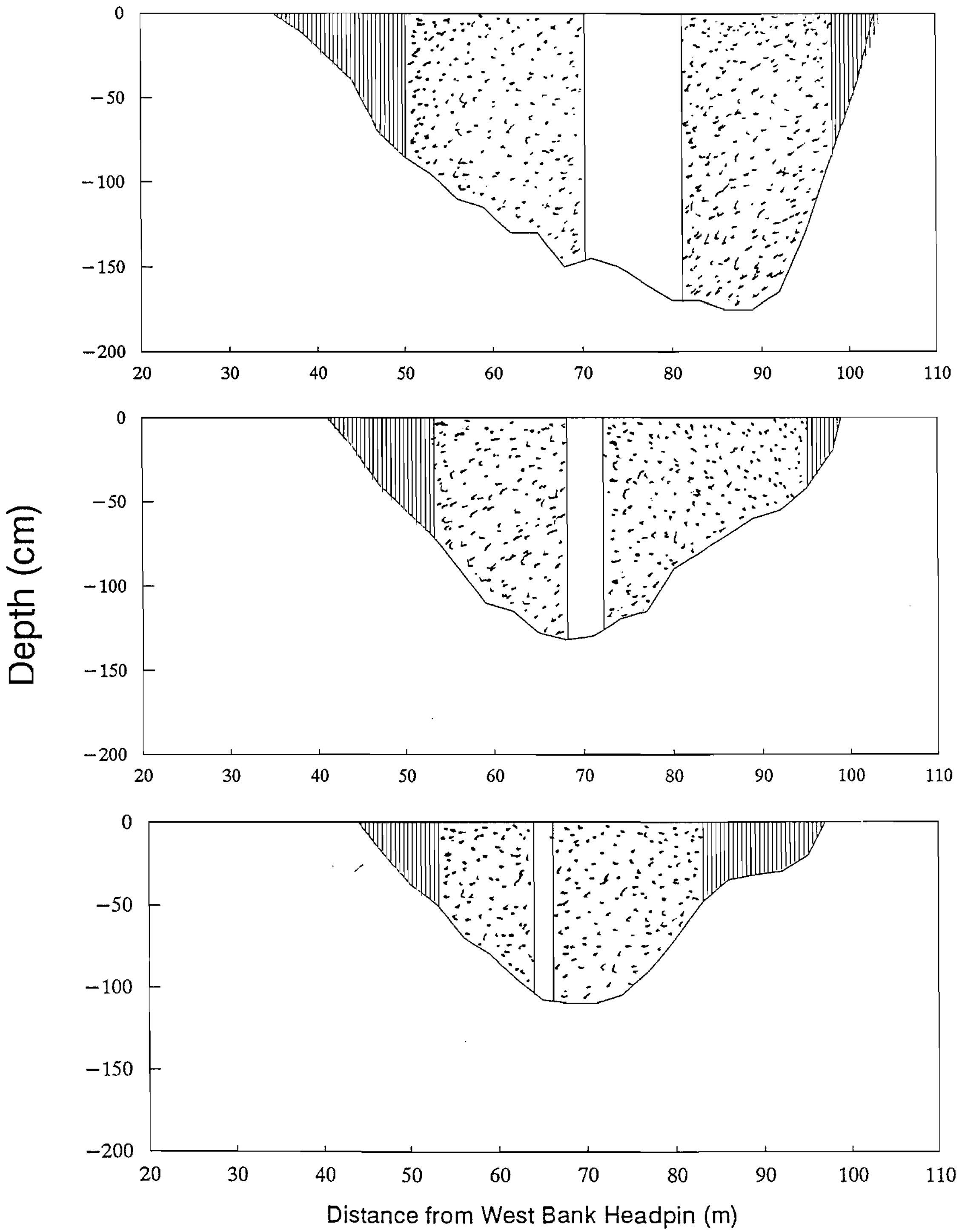

Figure 3. Anvik River depth profiles, 21 June (top), 10 July (middle), and 24 July (bottom) 1993. Stippled areas are approximate insonification zones; weired areas are indicated by vertical lines.

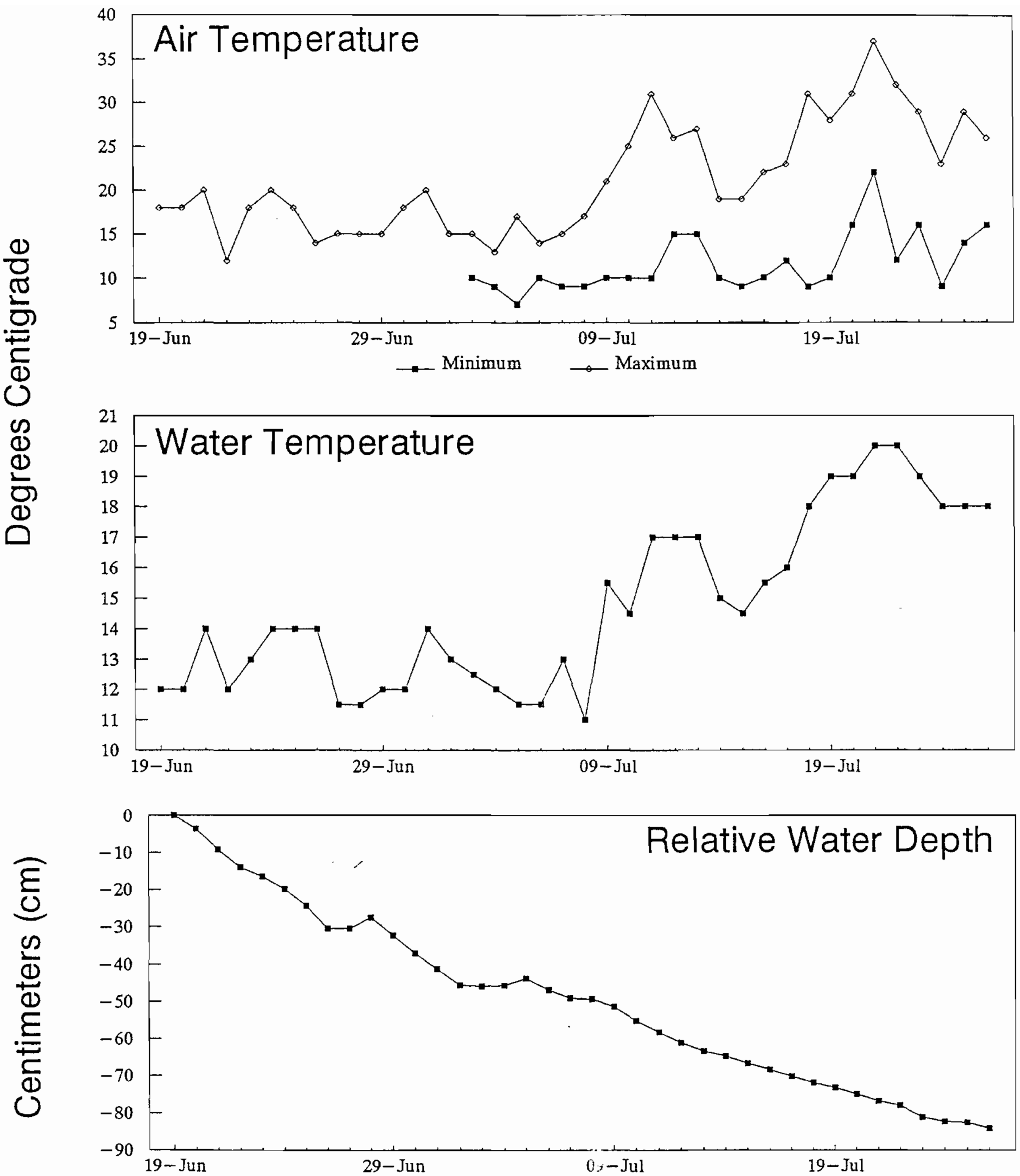

Figure 4. Daily minimum and maximum air temperatures, instantaneous water temperature, and relative water depth measured at approximately 1800 hours daily at the Anvik River sonar site, 1993. Minimum air temperatures for the period 19 June – 2 July are unavailable.

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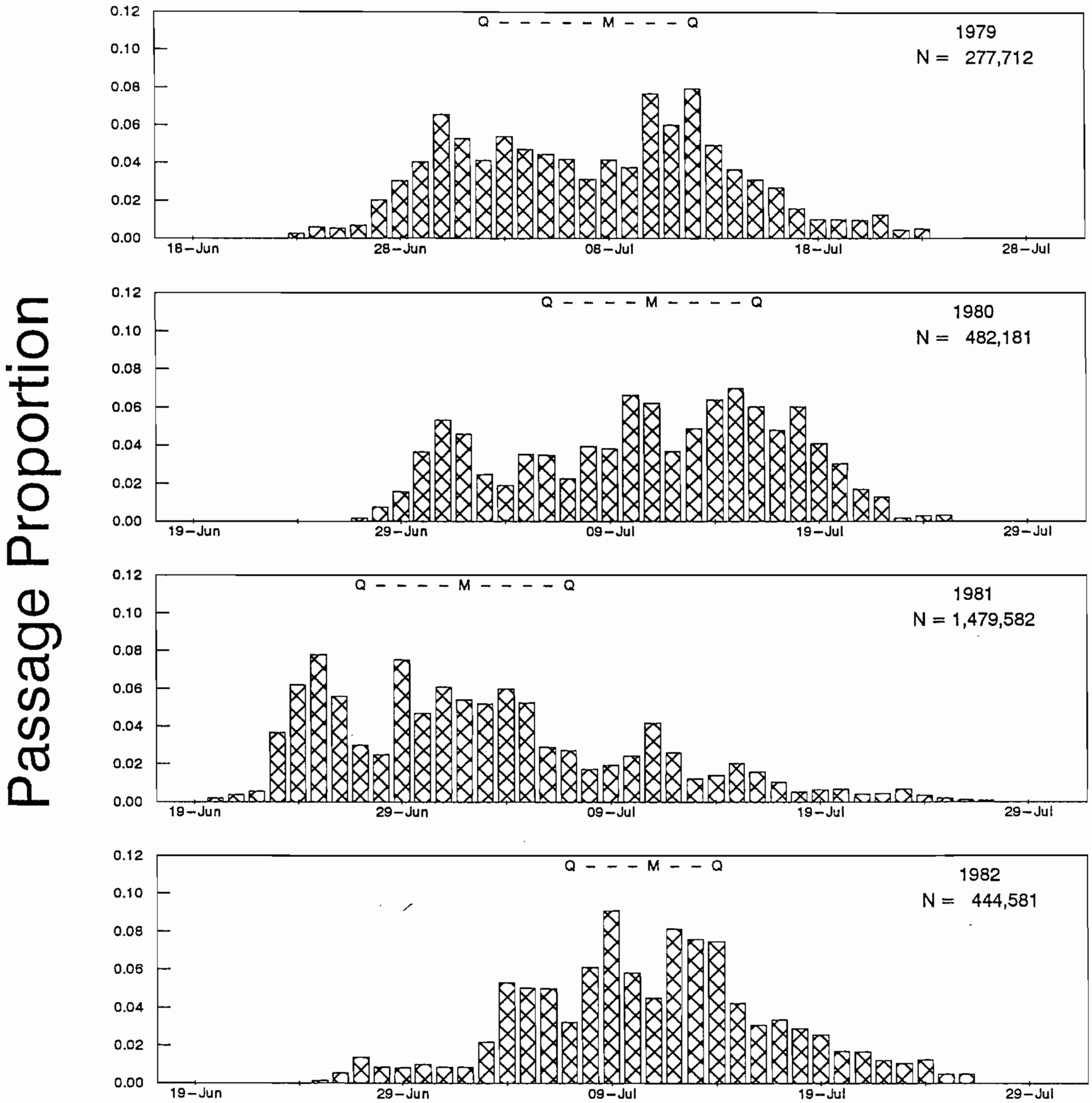

Figure 5. Daily proportion of corrected Anvik River sonar counts of summer chum salmon passage by day, 1979–1993 (N = total number of corrected counts). The first and third quartile passage days are indicated by the "Q"s, while the median day of passage is indicated by the "M".

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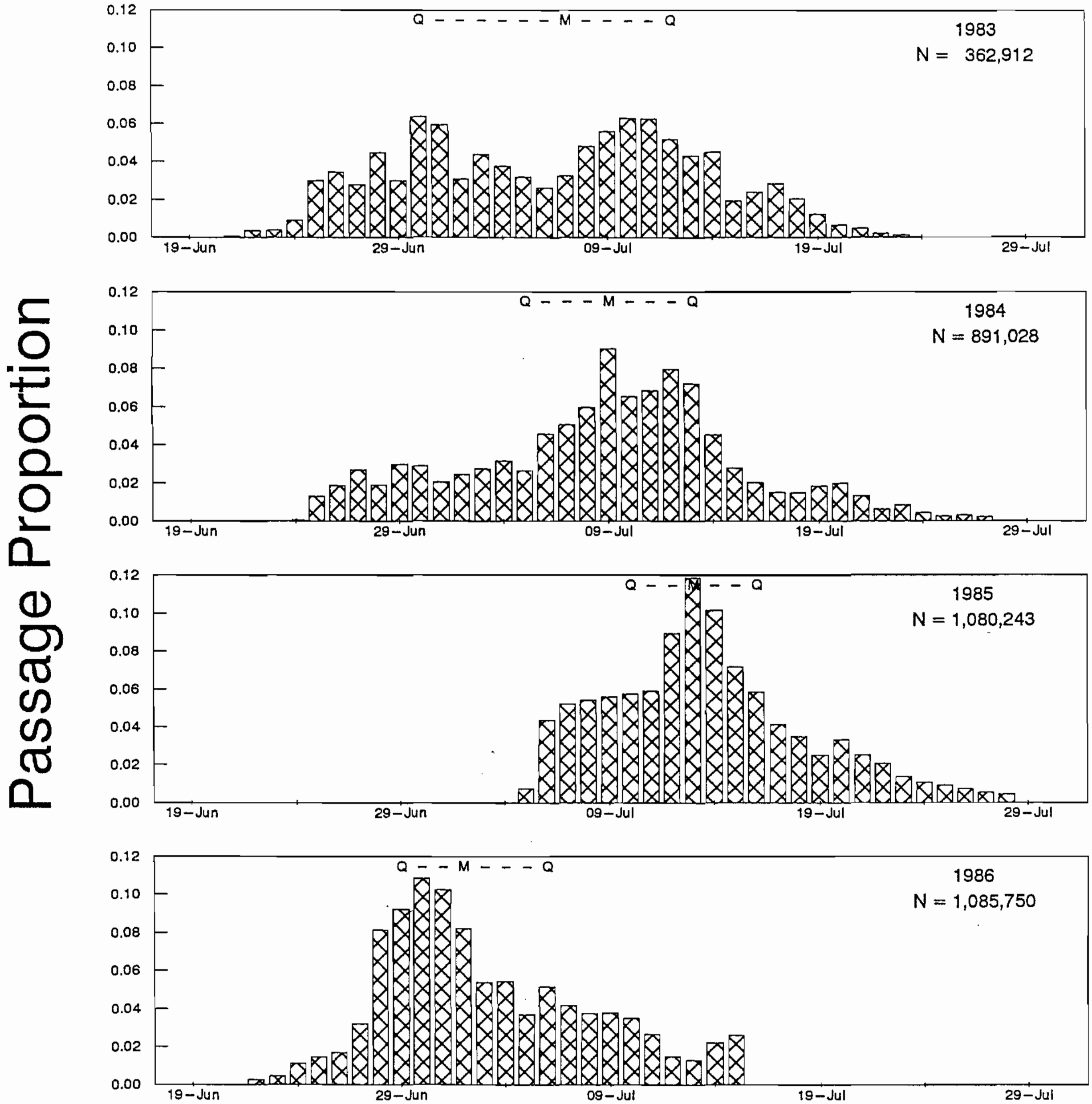

Figure 5. (page 2 of 4).

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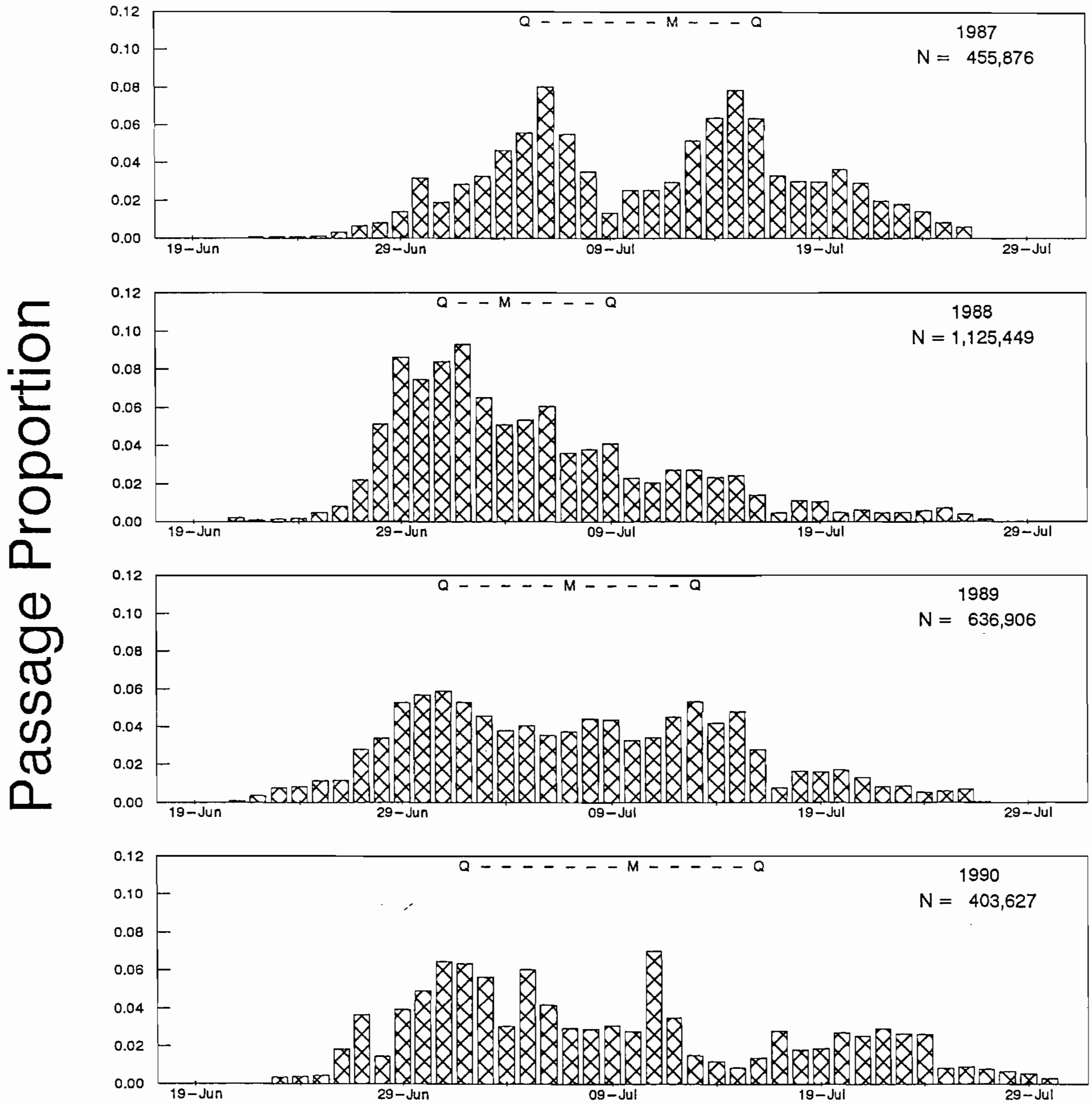

Figure 5. (page 3 of 4).

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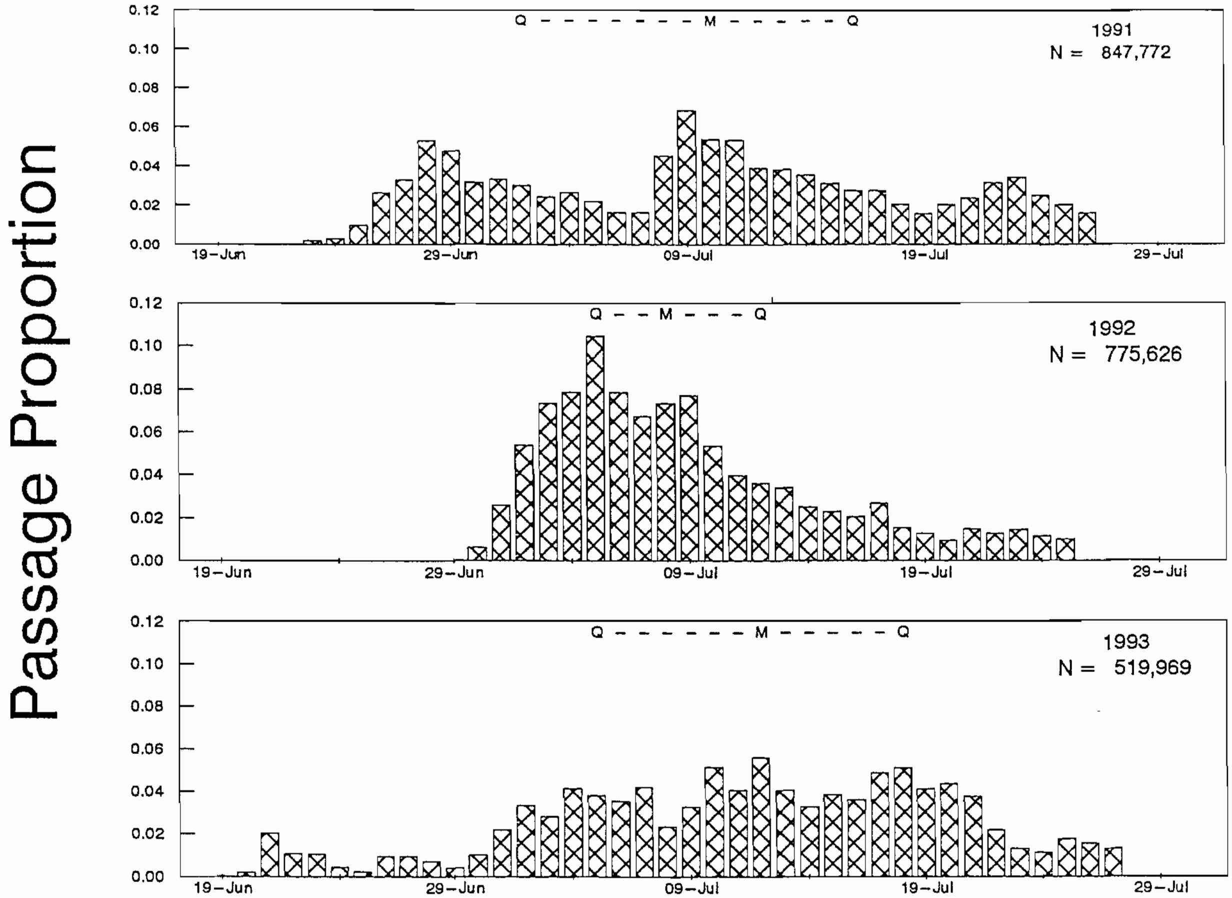

Figure 5. (page 4 of 4).

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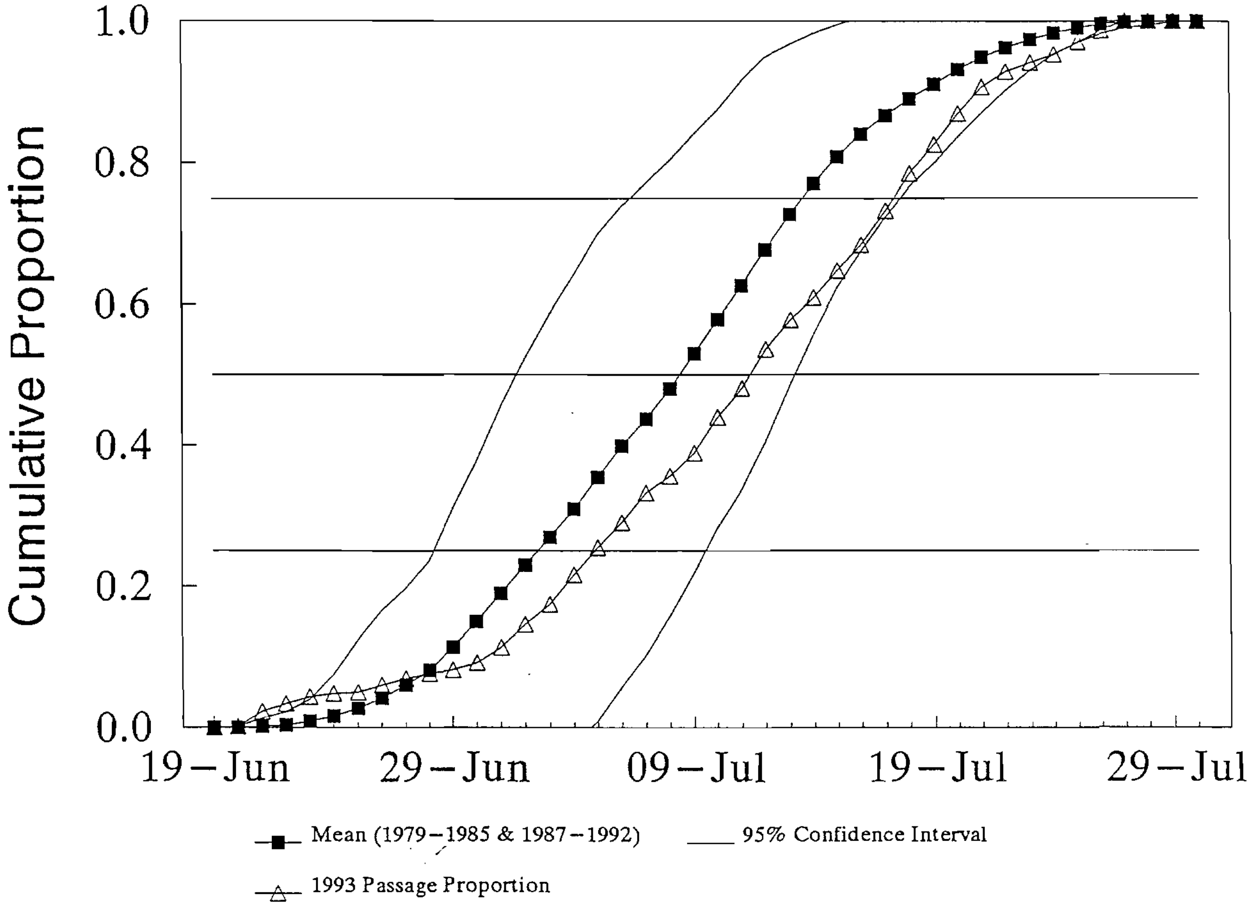

Figure 6. Mean (1979–1985 & 1987–1992) and the 1993 run timing curves for Anvik River summer chum salmon. Horizontal lines indicate the quartile proportions.

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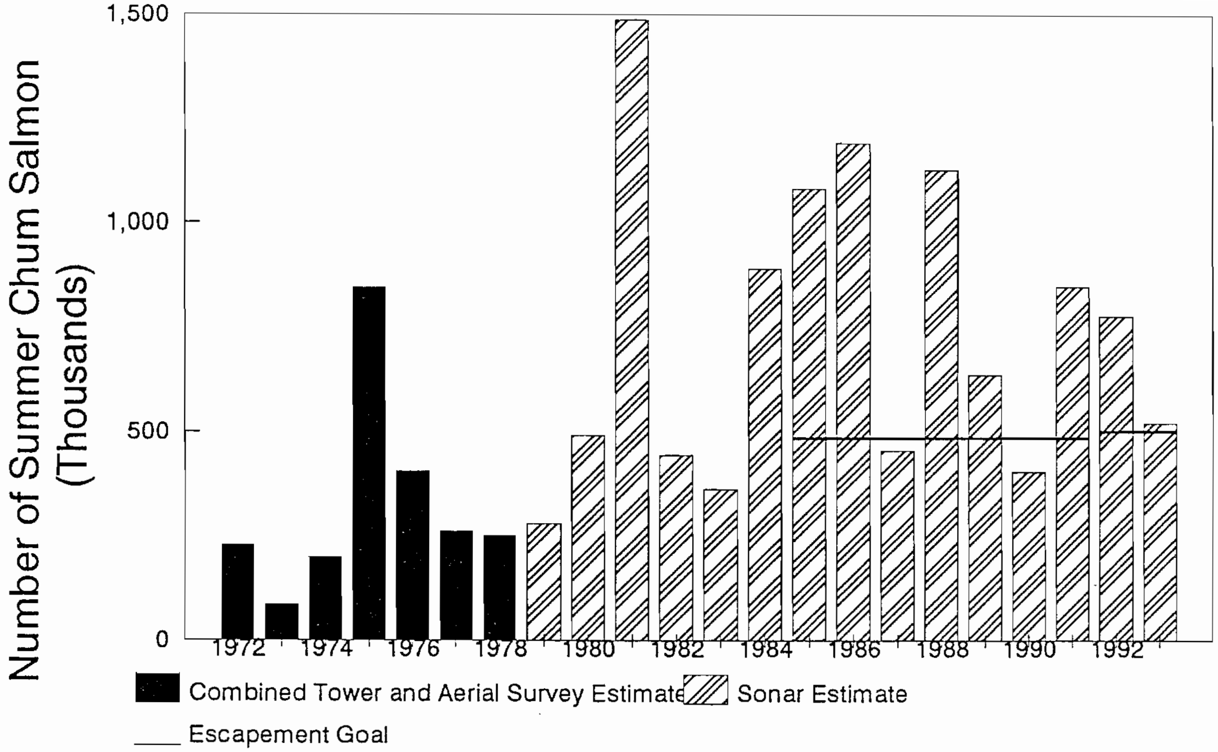

Figure 7. Anvik River summer chum salmon escapement estimated by combined tower and aerial survey count, 1972–1978, and by side–scanning sonar, 1979–1993. Sonar count escapement goal of 487,000 salmon, effective from 1985 to 1991, and the present, minimum escapement goal of 500,000 salmon are indicated by the horizontal lines.

13–Oct–94:SSONVIK.WK3

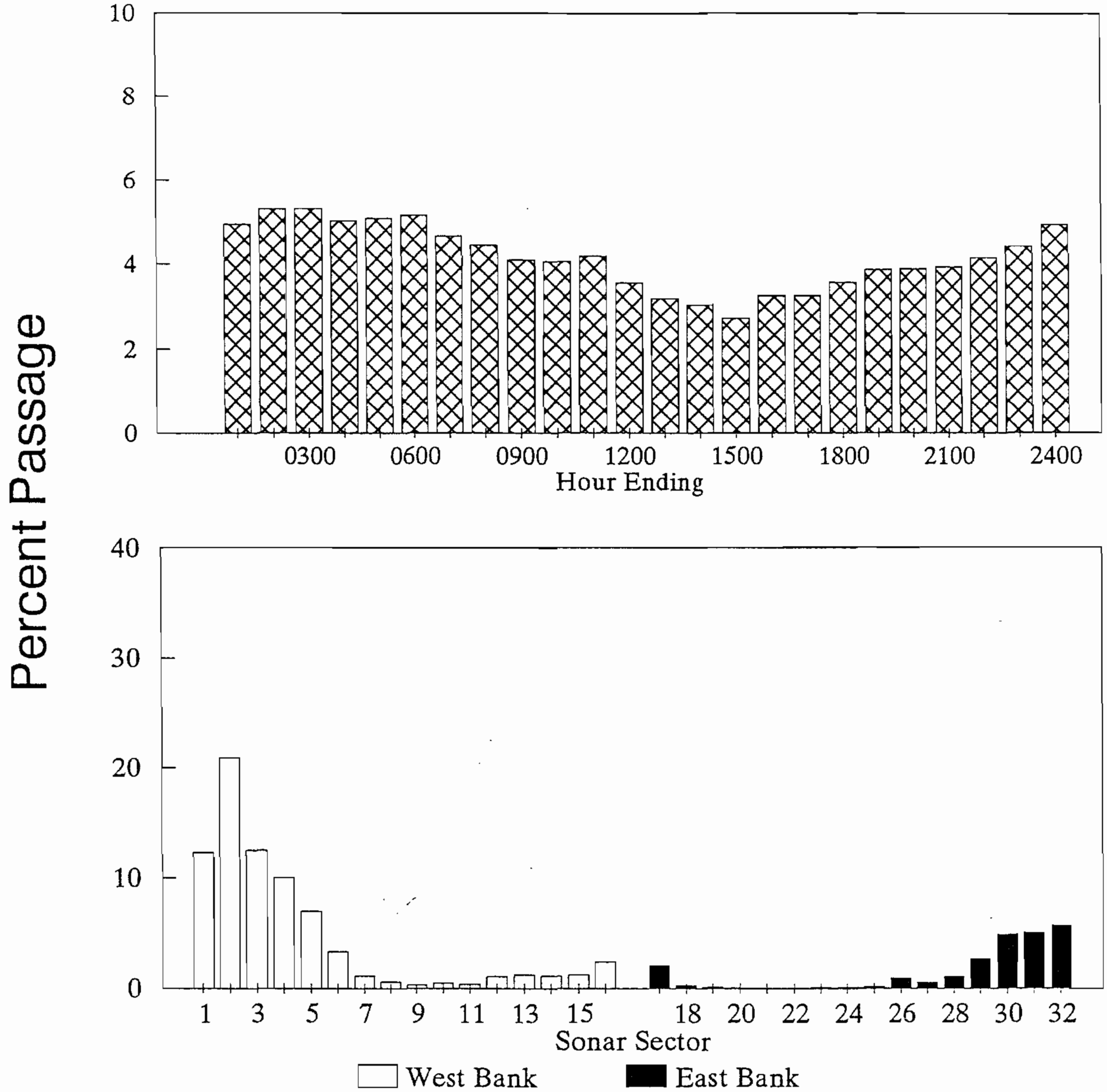

Figure 8. Estimated percent of the total summer chum salmon passage, 517,409 salmon, in relation to hour of the day (above) and sonar sector (below), Anvik River sonar site, 19 June – 27 July, 1993.

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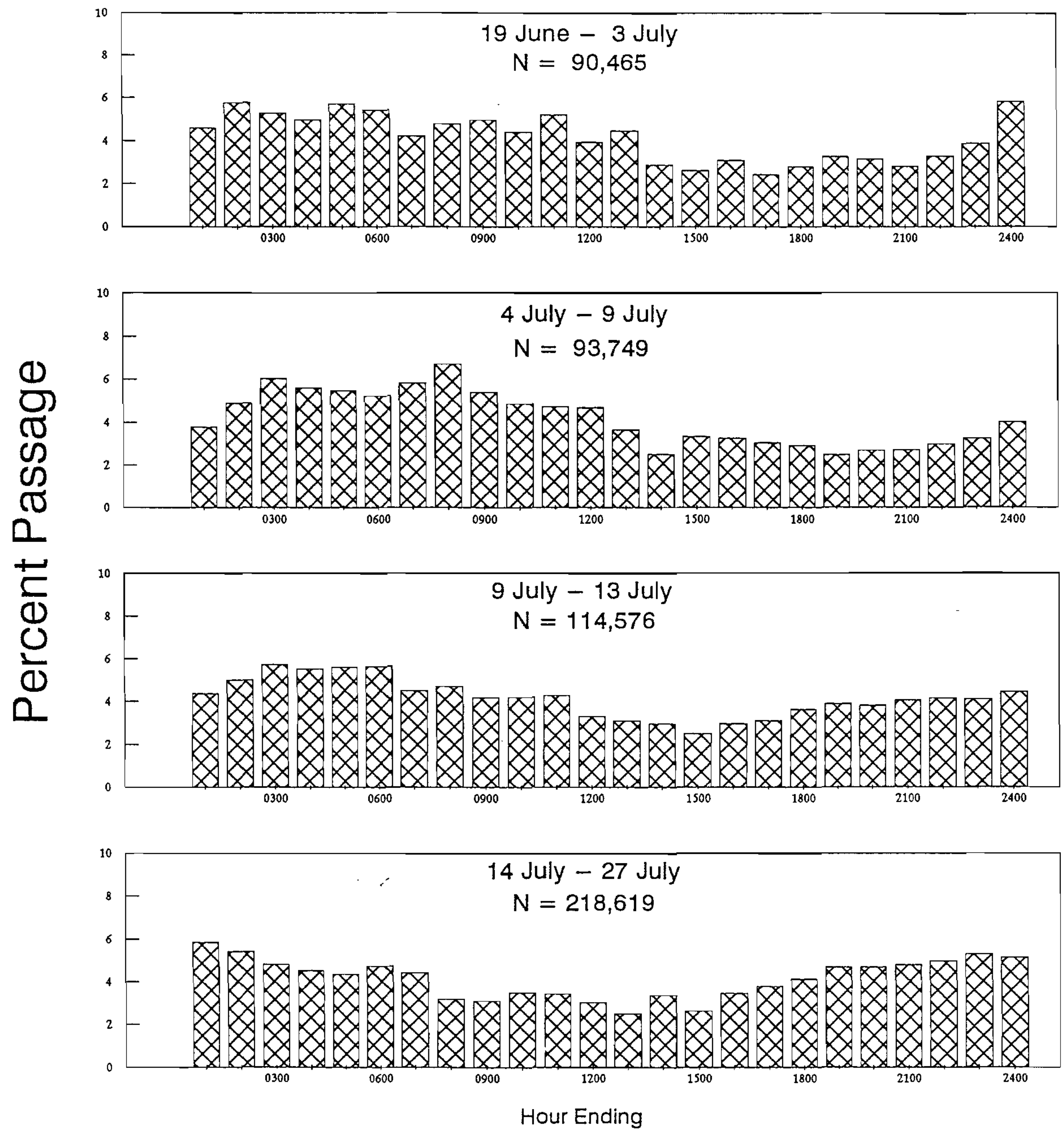

Figure 9. Estimated percent of summer chum salmon passage by sampling stratum and hour of the day, Anvik River, 1993.

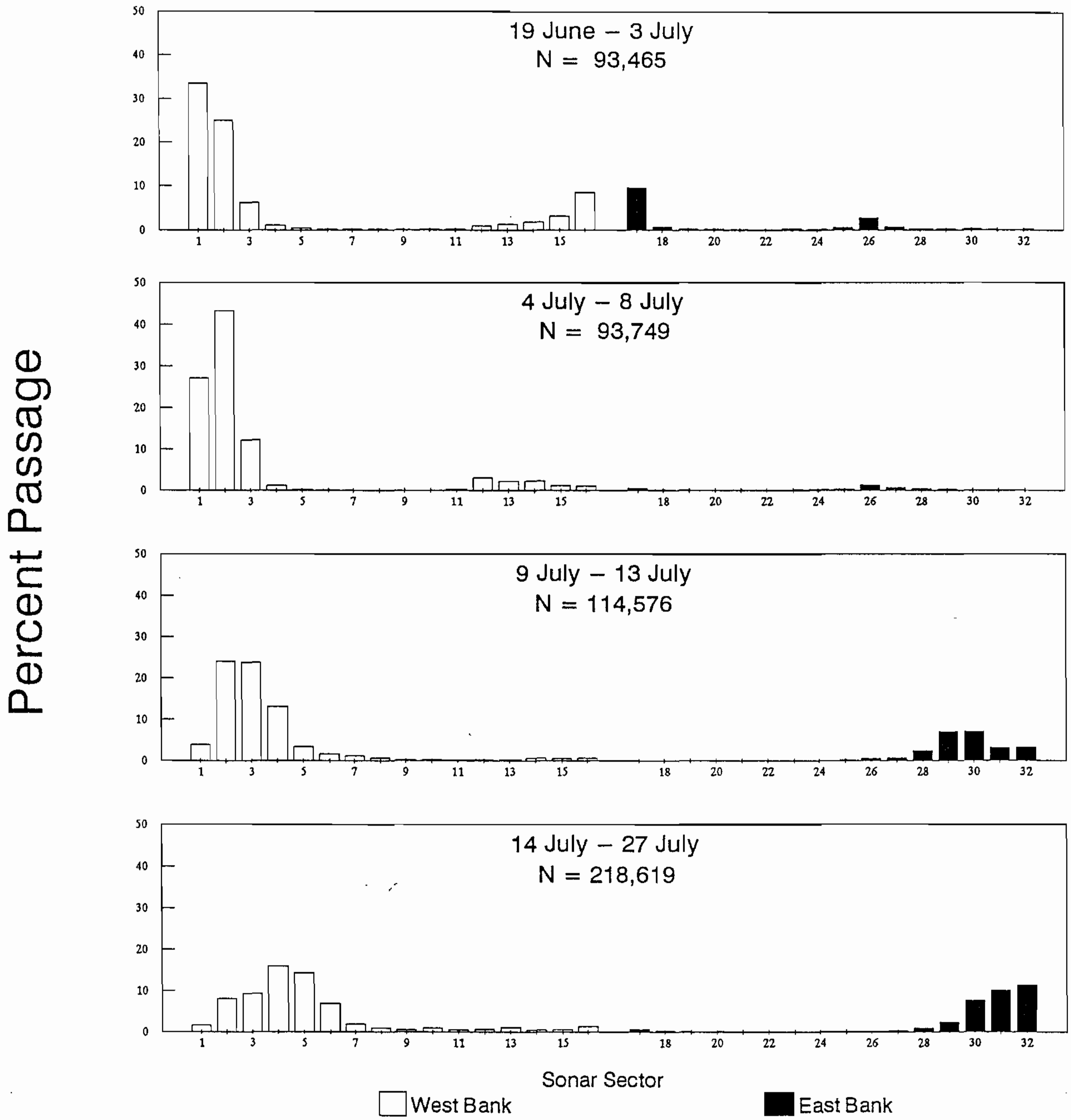

Figure 10. Estimated percent of summer chum salmon passage by sampling stratum and sonar sector, Anvik River, 1993.

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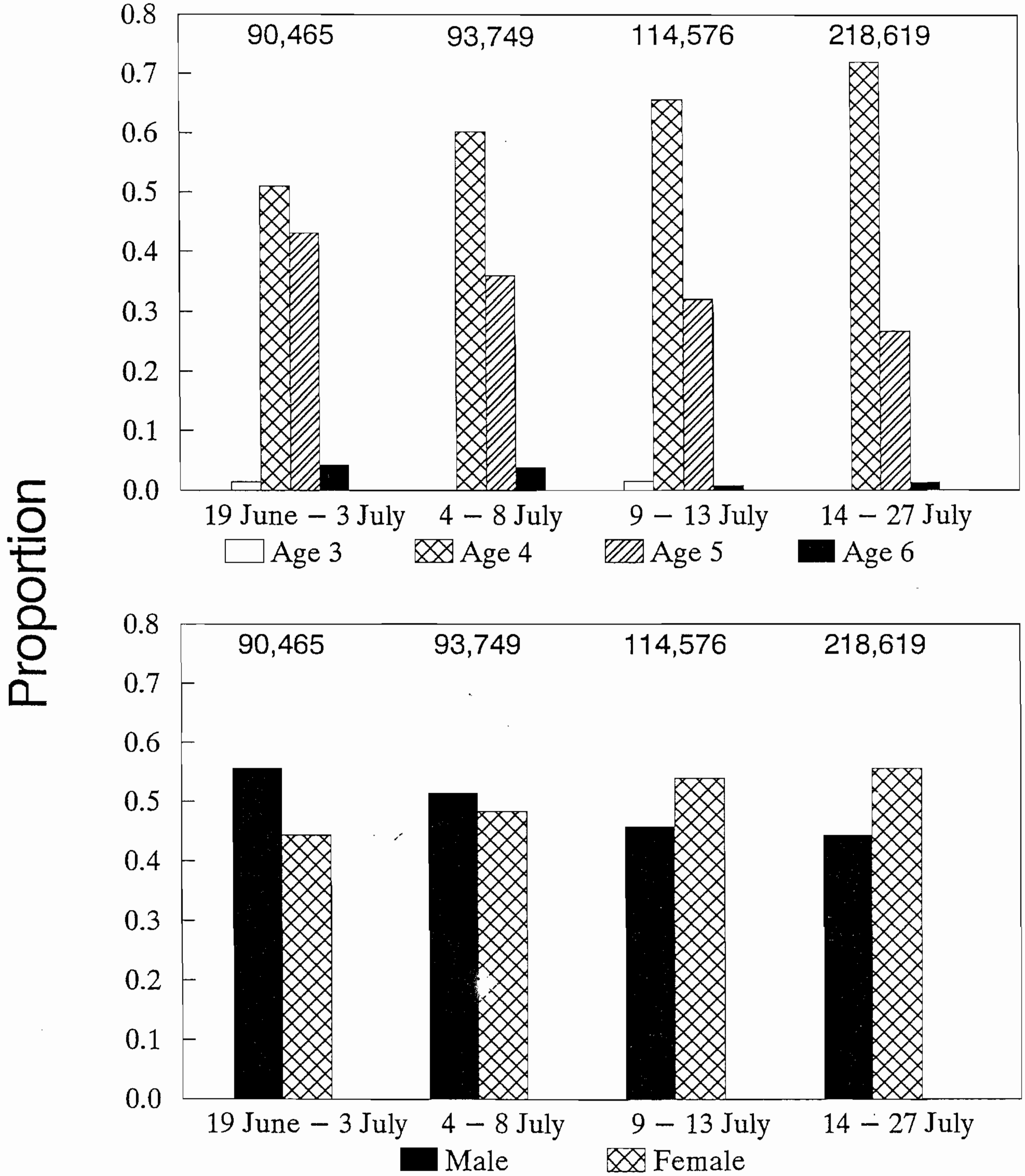

Figure 11. Age and sex compositon of sampled Anvik River summer chum salmon by sampling stratum, 1993. Numbers above bars indicate estimated passage during that stratum.

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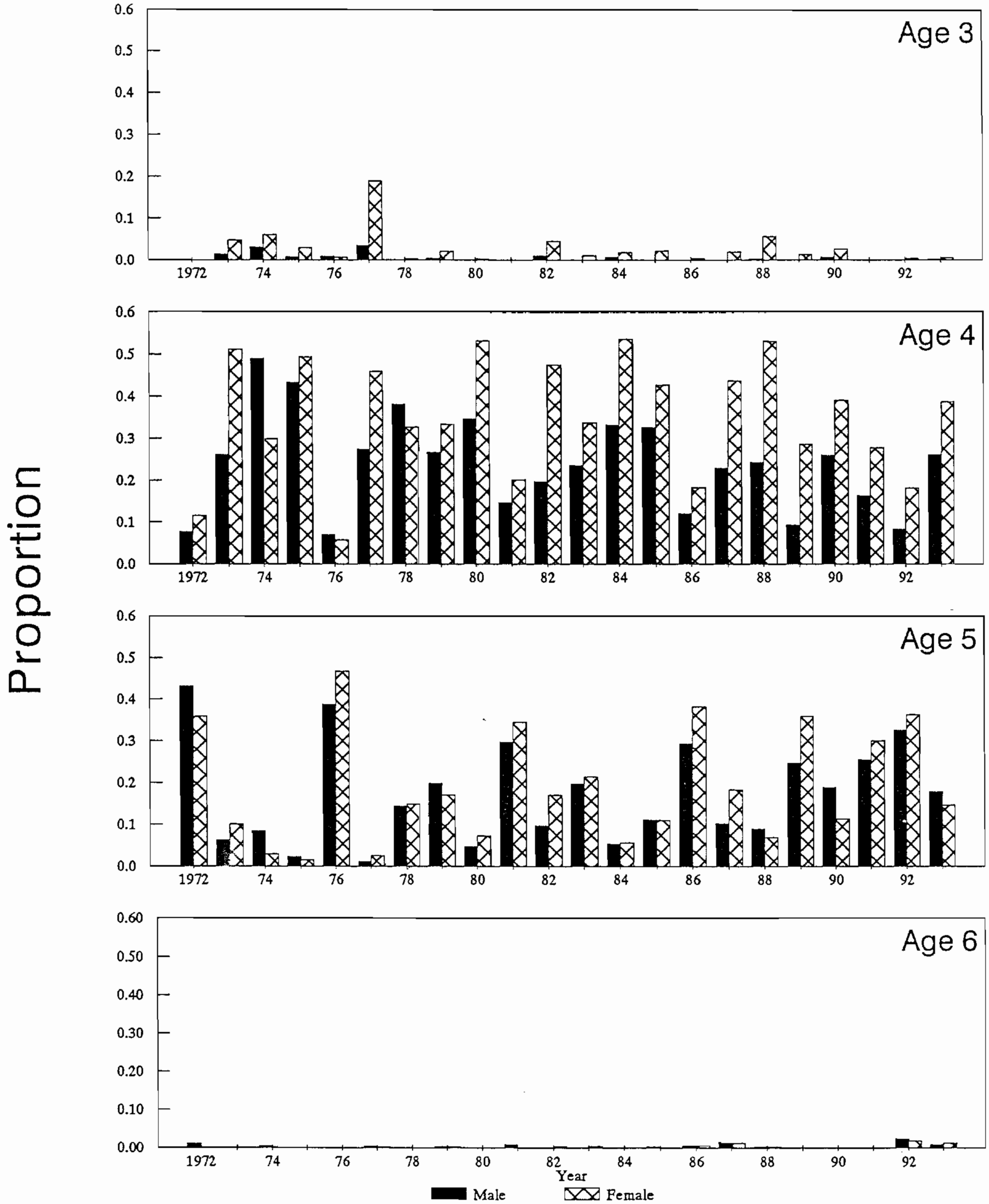

Figure 12. Estimated age and sex compostion of the Anvik River summer chum salmon escapement, 1972–1993.

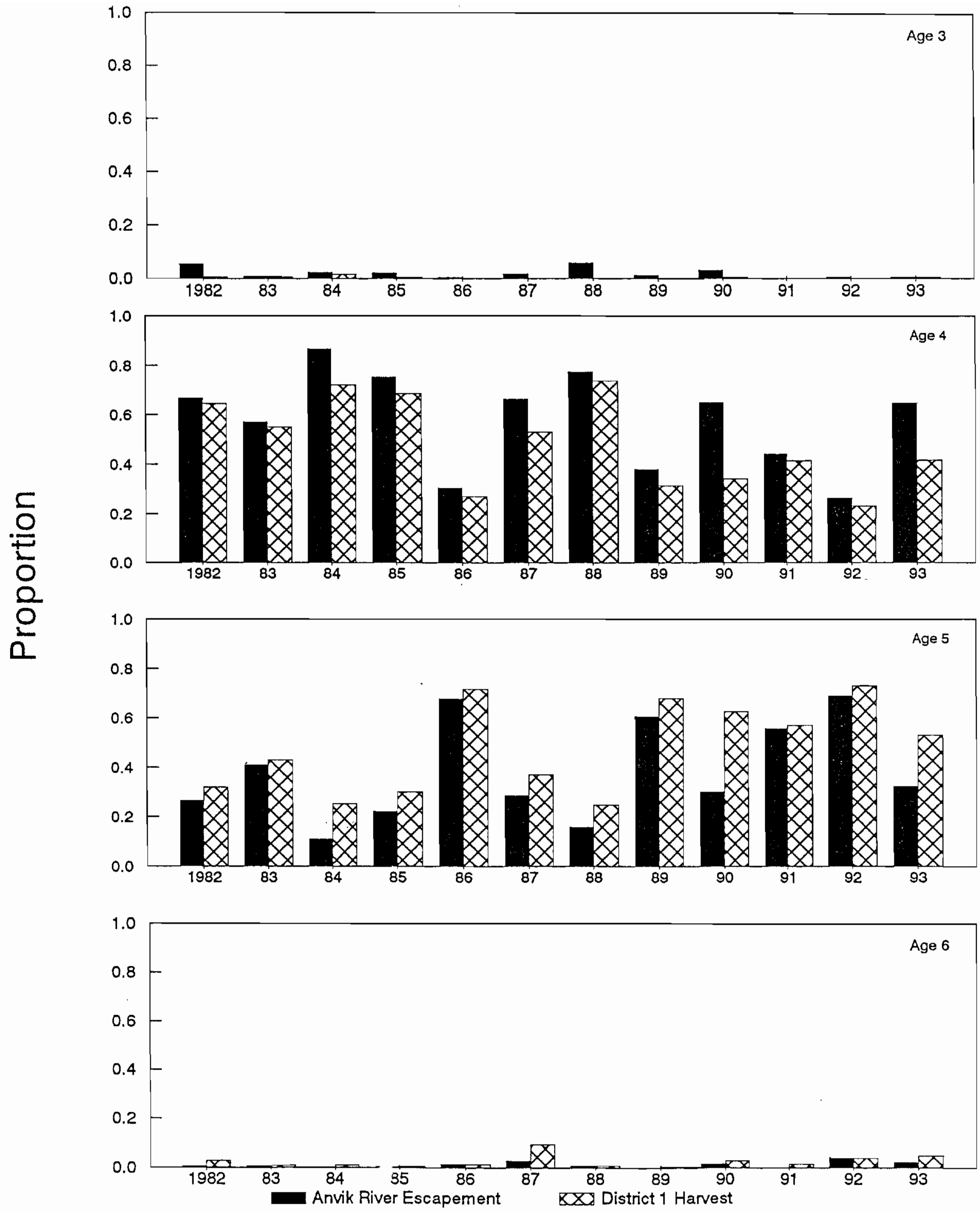

Figure 13. Estimated age compostion of the Anvik River summer chum salmon escapement and District 1 commercial harvest, 1982–1993.

23–Sep–94:SAGEVIK.WK3

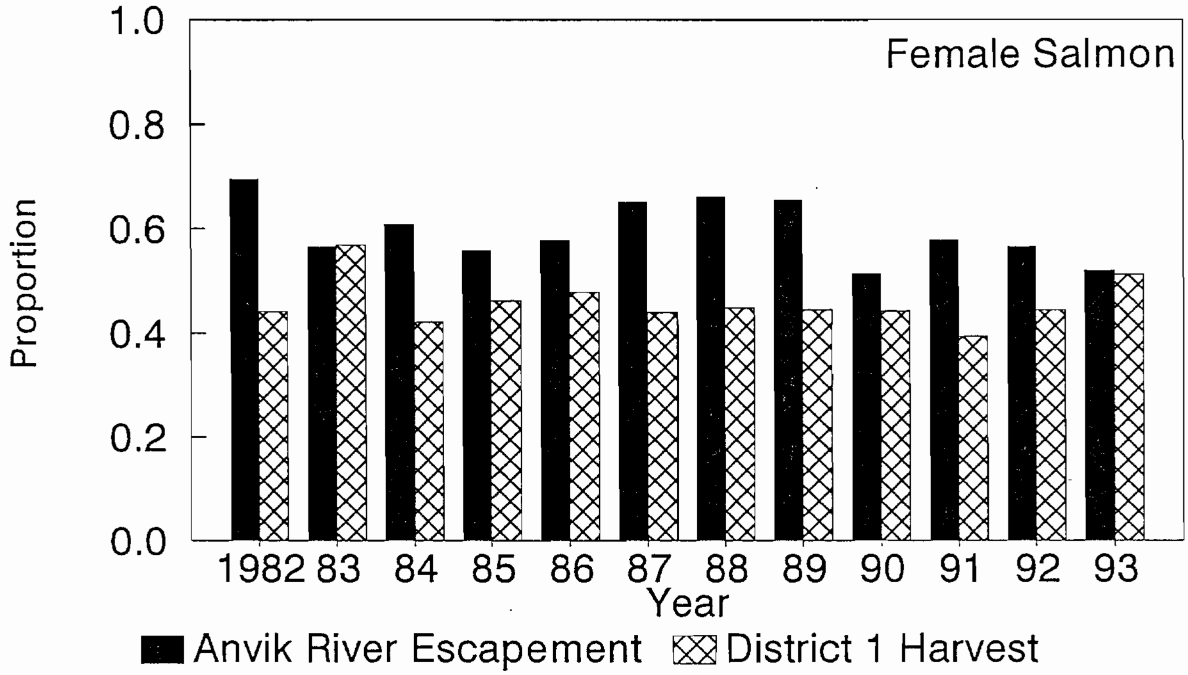

Figure 14. Estimated proportion of female chum salmon in the Anvik River escapement and the District 1 commercial harvest, 1982–1993.

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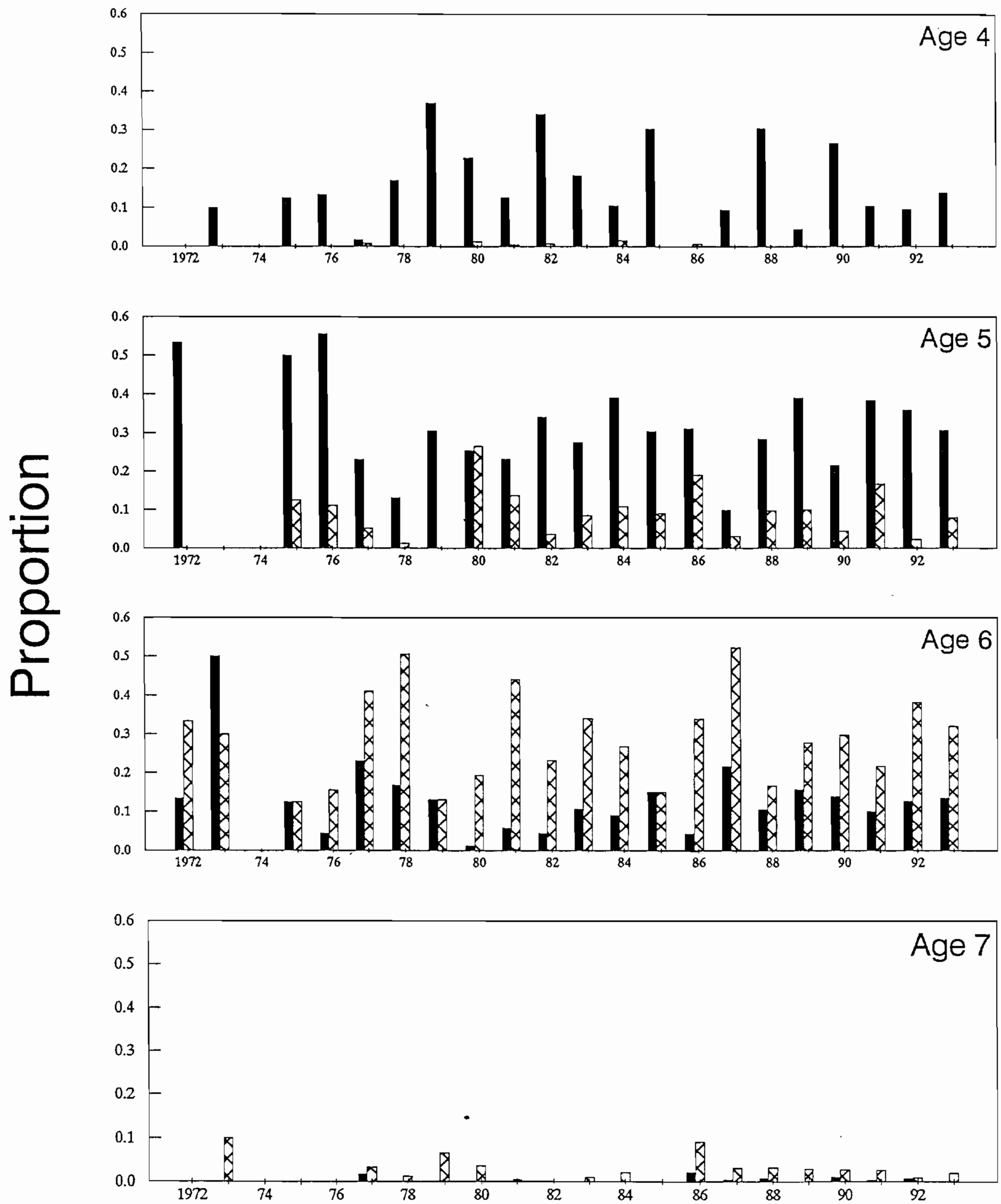

Figure 15. Estimated age and sex compostion of the Anvik River chinook salmon escapement, 1972–1993.

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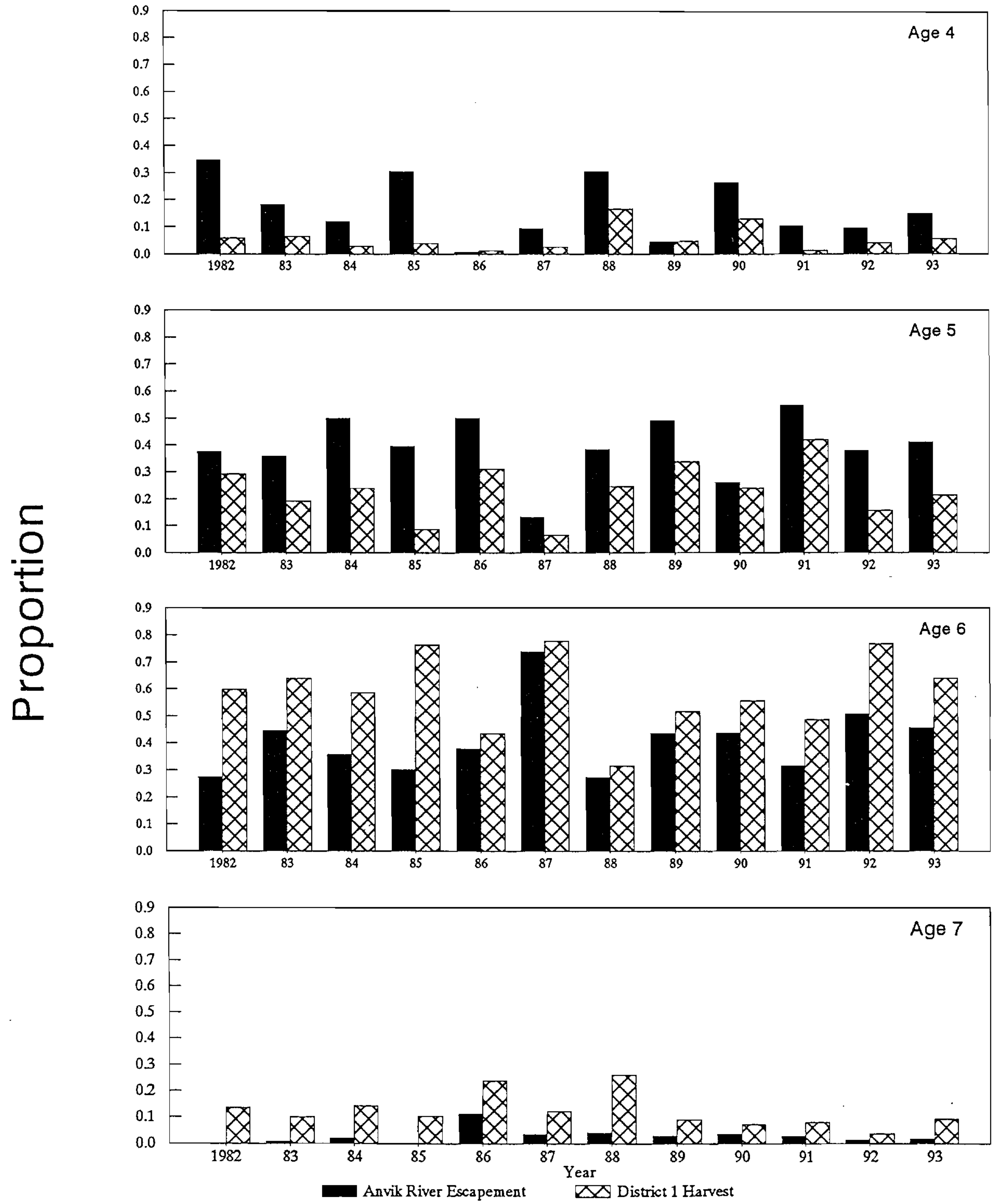

Figure 16. Estimated age composition of the Anvik River chinook salmon escapement and the District 1 commercial harvest, Yukon River, 1982–1993.

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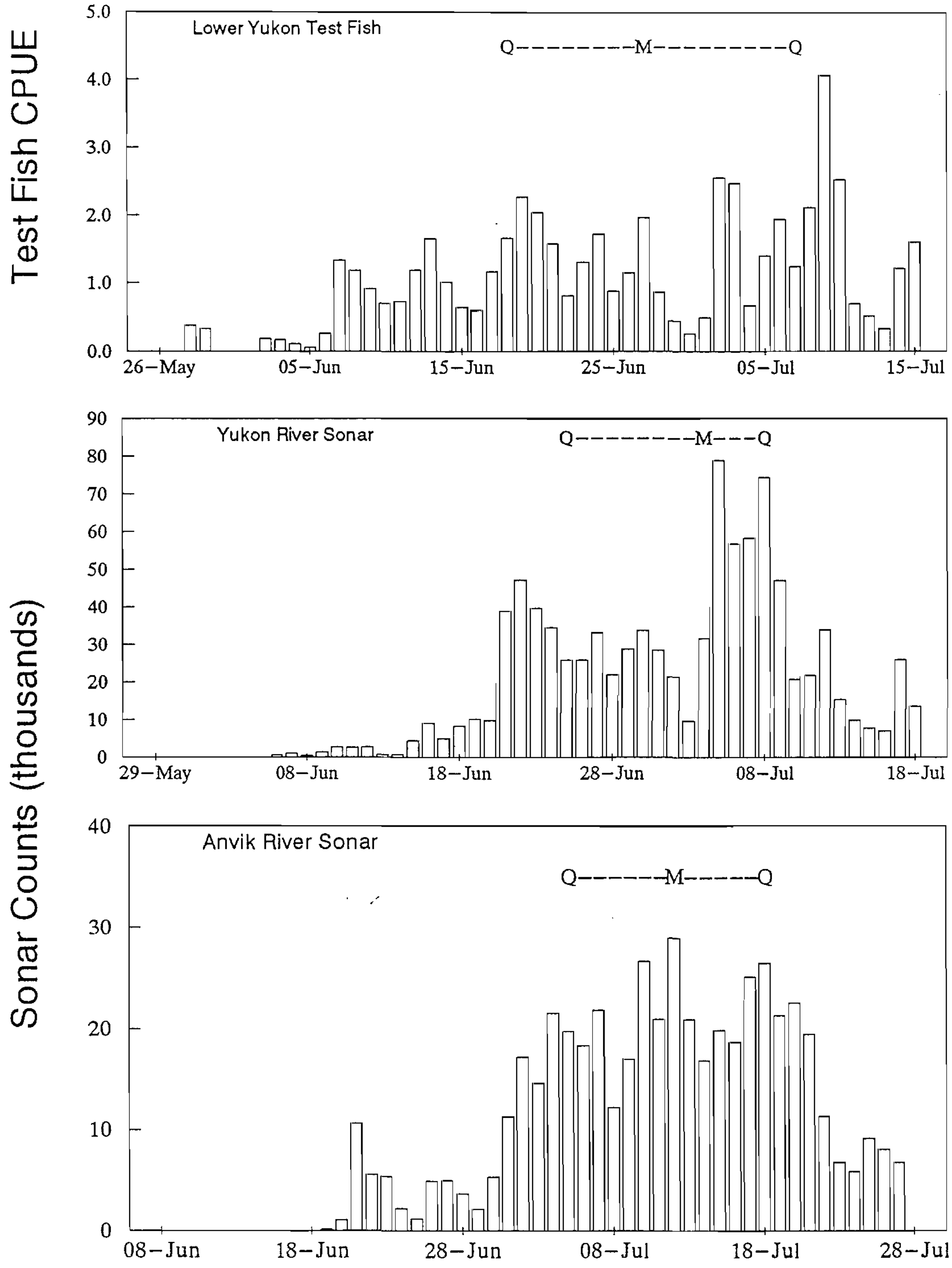

Figure 17. Run timing of Yukon River summer chum salmon in 1993 as indicated by Lower Yukon test fish CPUE, Yukon sonar counts, and Anvik River sonar counts. First and third quartile passage days are indicated by the "Q"s, while the median passage day is indicated by the "M". Note that the Yukon Sonar and Anvik River sonar graph are time lagged by 3 and 13 days, respectively, from the lower Yukon River test fish graph.

13-Oct-94:c:\anvik\1993\runtiming.wk3

APPENDIX

Appendix A. West bank Anvik River corrected sonar counts by hour and date, 19 June – 27 July, 1993.

Hour Ending	19–June[a]	20–Jun	21–Jun	22–Jun	23–Jun	24–Jun	25–Jun	26–Jun	27–Jun	28–Jun[a]	29–Jun	30–Jun	01–Jul	02–Jul	03–Jul	04–Jul	05–Jul	06–Jul	07–Jul
01:00		6	186	307	35	165	0	100	147	97	28	243	480	886	1,247	335	561	714	1,171
02:00		3	141	216	84	19	0	173	375	107	19	327	673	973	1,052	670	673	846	1,470
03:00		4	197	74	46	28	0	266	234	188	22	184	690	791	1,066	701	1,115	852	1,895
04:00		6	144	64	47	34	0	187	328	227	18	106	456	746	988	817	902	1,013	1,524
05:00		4	274	61	21	25	0	95	300	152	18	212	280	1,265	881	960	770	1,010	1,166
06:00		6	375	76	35	33	0	57	436	59	32	182	399	769	782	820	905	907	1,334
07:00		5	293	361	122	59	0	74	216	84	248	173	418	76	728	1,361	794	1,027	1,404
08:00		4	214	537	214	71	0	230	205	88	105	327	318	405	543	1,661	1,066	1,181	1,417
09:00		2	78	199	547	88	0	163	213	226	86	260	271	1,053	583	1,391	931	753	1,168
10:00		0	142	85	398	108	0	155	343	188	68	146	280	932	475	1,210	813	500	1,193
11:00		64	87	336	919	67	0	224	200	185	105	123	190	1,199	497	1,433	875	433	1,054
12:00		41	168	295	776	111	0	170	185	176	66	199	50	579	507	1,574	783	475	1,058
13:00		13	121	517	455	71	0	168	123	368	63	251	366	599	397	1,104	782	483	562
14:00		35	59	219	87	60	0	213	131	176	61	296	421	475	253	634	591	367	391
15:00		29	149	253	52	78	0	150	121	143	92	197	315	312	263	868	779	520	417
16:00	12	47	372	274	74	66	54	145	108	102	92	230	368	281	273	1,024	795	462	356
17:00	14	81	7	266	47	71	144	122	61	82	123	290	345	185	284	644	718	502	558
18:00	6	50	422	316	28	58	190	163	102	101	122	180	273	211	183	604	819	406	432
19:00	2	94	134	391	108	63	91	163	69	84	77	95	288	296	225	380	601	497	402
20:00	3	74	42	100	150	63	110	182	72	22	95	133	237	568	219	400	597	658	446
21:00	5	76	35	55	192	64	69	194	52	28	133	171	368	500	236	400	601	716	393
22:00	32	101	1	48	279	61	125	217	57	62	140	155	475	774	253	400	711	870	346
23:00	52	144	1	35	266	47	45	264	43	96	162	214	682	921	332	400	726	942	563
24:00	58	177	761	21	219	63	195	264	63	79	174	316	659	1,623	362	612	706	1,383	538
Total	184	1,066	4,403	5,106	5,201	1,573	1,023	4,139	4,184	3,120	2,149	5,010	9,302	16,419	12,629	20,403	18,614	17,517	21,258

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Appendix A. (p 2 of 2).

Hour Ending	08–Jul	09–Jul	10–Jul	11–Jul	12–Jul	13–Jul	14–Jul	15–Jul	16–Jul	17–Jul	18–Jul	19–Jul	20–Jul	21–Jul	22–Jul	23–Jul	24–Jul	25–Jul	26–Jul	27–Jul
0100	602	408	1,038	809	793	825	949	780	1,055	721	958	634	681	653	289	267	182	308	297	224
0200	845	739	1,124	1,040	1,023	916	945	845	1,012	630	841	544	662	358	155	195	128	393	246	167
0300	941	923	1,417	1,319	997	933	1,018	832	922	649	778	437	365	436	106	124	126	263	147	267
0400	843	849	1,344	1,293	1,031	851	585	842	877	693	845	527	334	412	120	100	65	263	108	99
0500	880	778	1,389	1,024	1,346	709	701	701	900	686	993	419	294	343	159	209	122	134	202	119
0600	540	770	1,403	1,172	1,043	618	582	804	785	980	1,211	629	432	347	213	105	152	300	181	126
0700	533	803	1,056	938	720	402	615	624	596	1,118	705	539	600	368	259	109	153	267	278	322
0800	699	789	1,269	1,049	535	395	424	428	544	972	532	382	451	284	190	119	160	250	126	181
0900	571	722	1,412	702	454	336	447	571	618	1,160	375	268	331	251	179	111	212	232	77	97
1000	604	775	1,246	602	488	314	495	629	572	885	451	369	364	257	234	98	160	171	80	96
1100	444	789	1,214	520	436	373	615	673	525	636	571	377	310	228	180	152	165	307	158	122
1200	356	659	1,051	577	422	345	458	559	492	658	679	311	391	315	203	116	218	207	114	189
1300	363	609	746	548	476	345	589	426	474	575	624	293	410	262	115	93	95	191	167	188
1400	236	468	777	523	480	407	660	575	473	624	424	393	439	535	190	115	112	348	177	266
1500	350	271	638	580	391	431	374	535	296	580	727	401	465	489	235	150	96	265	153	139
1600	217	243	756	523	403	593	437	627	345	616	563	597	807	729	483	238	104	302	181	289
1700	261	211	827	704	387	505	438	654	348	481	699	625	710	839	640	235	185	427	335	167
1800	301	324	959	661	321	559	367	587	298	469	758	719	897	833	602	261	225	328	268	219
1900	297	619	979	698	400	458	384	657	427	402	779	743	887	945	427	296	275	422	313	137
2000	255	717	860	646	481	429	400	825	318	536	526	527	799	642	310	319	176	301	426	142
2100	246	831	756	480	392	499	387	767	386	817	525	479	711	492	394	281	138	277	321	194
2200	251	877	657	450	547	573	286	664	428	625	501	531	704	315	379	246	192	378	440	129
2300	247	720	712	477	612	654	530	712	364	631	439	578	638	415	256	176	214	177	297	93
2400	342	819	899	673	721	757	601	814	404	712	535	743	440	375	132	260	234	292	310	125
Total	11,224	15,713	24,529	18,008	14,899	13,227	13,287	16,131	13,459	16,856	16,039	12,065	13,122	11,123	6,450	4,375	3,889	6,803	5,402	4,097

[a] Counting initiated on 19 June at 1500 hours.

Appendix B. East bank Anvik River corrected sonar counts by hour and date, 19 June – 27 July, 1993.

Hour Ending	19–Jun	20–June[a]	21–Jun	22–Jun	23–Jun	24–Jun	25–Jun[b]	26–Jun[b]	27–Jun[b]	28–Jun[b]	29–Jun	30–Jun	01–Jul	02–Jul	03–Jul	04–Jul	05–Jul	06–Jul	07–Jul
01:00			31	5	8	12	2	7	7	5	0	1	29	19	118	10	34	66	19
02:00			796	13	0	0	0	0	0	0	0	10	151	16	89	20	28	6	8
03:00			714	5	0	0	0	0	0	0	0	3	133	14	128	20	23	46	13
04:00			849	10	0	0	0	0	0	0	0	0	70	9	207	58	41	38	14
05:00			1,142	5	0	0	0	0	0	0	0	5	178	42	207	133	54	54	58
06:00			1,115	25	0	0	0	0	0	0	0	55	286	49	132	137	92	74	30
07:00			335	58	0	31	4	18	18	14	0	4	283	79	95	50	79	104	27
08:00			606	72	0	46	7	27	27	20	0	10	109	44	114	66	72	39	29
09:00			249	74	0	11	4	16	16	12	1	25	78	69	189	12	64	54	67
10:00			82	29	0	0	0	0	0	0	0	56	187	110	228	28	69	50	53
11:00			33	33	0	0	0	0	0	0	0	29	212	63	161	45	24	48	37
12:00			24	57	0	0	0	0	0	0	0	2	93	24	40	48	29	21	5
13:00			24	28	0	0	34	136	137	102	14	20	31	4	15	37	30	15	13
14:00			10	0	0	0	2	10	10	7	1	8	6	41	15	27	53	18	6
15:00			46	10	0	0	7	29	29	22	3	18	13	22	13	69	34	31	13
16:00			52	0	0	0	17	68	69	51	7	6	4	27	11	85	56	14	9
17:00			39	0	0	0	0	0	0	0	0	4	5	18	9	32	51	20	19
18:00		0	35	9	0	2	3	11	11	8	1	5	9	23	7	20	47	45	21
19:00		0	16	16	2	230	38	154	155	115	2	12	5	15	25	33	48	21	20
20:00		0	0	9	18	242	40	161	162	121	2	0	6	0	40	47	36	9	22
21:00		0	0	0	25	92	16	63	64	48	1	1	1	33	31	40	45	21	26
22:00		1	1	0	27	0	7	29	29	22	3	3	7	30	50	19	73	37	24
23:00		1	0	0	28	0	5	19	20	15	2	11	15	57	36	44	47	16	38
24:00		4	0	0	35	0	7	29	29	22	3	1	83	22	33	68	36	16	26
Total		6	6,199	458	143	666	193	777	783	584	40	289	1,994	830	1,993	1,148	1,165	863	597

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Appendix B. (page 2 of 2).

Hour Ending	08-Jul	09-Jul	10-Jul[c]	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul
01:00	30	57	180	302	309	293	345	364	249	389	685	333	515	831	271	148	142	105	140	306
02:00	26	73	127	181	263	252	253	419	315	478	595	341	539	811	240	149	73	202	163	203
03:00	40	83	92	100	324	367	156	280	222	521	652	268	455	624	284	111	67	75	133	237
04:00	18	87	75	63	460	301	295	292	183	481	719	257	383	625	270	72	61	128	91	165
05:00	47	82	63	44	511	489	266	227	302	350	717	166	349	441	263	125	155	87	24	115
06:00	61	74	66	57	785	504	182	239	178	197	906	183	420	455	245	83	195	100	65	87
07:00	74	74	45	16	721	407	271	163	226	255	663	235	335	258	199	82	74	91	137	124
08:00	67	83	61	38	680	499	100	70	186	115	246	224	221	147	186	188	26	93	67	72
09:00	40	35	30	25	634	466	84	68	194	221	251	218	244	203	125	91	31	42	65	49
10:00	43	46	29	11	804	520	222	94	133	437	246	404	372	265	275	98	41	69	49	45
11:00	55	13	11	8	918	655	44	53	173	381	98	470	293	324	286	75	73	113	108	21
12:00	37	36	40	43	439	181	73	42	87	328	96	281	202	148	116	100	33	61	86	72
13:00	27	47	87	126	436	137	10	37	15	158	10	61	176	150	50	96	47	51	53	62
14:00	20	67	172	276	150	99	13	33	5	113	1,056	87	113	221	74	52	24	36	184	66
15:00	38	32	68	104	182	158	83	15	116	63	37	126	66	124	55	63	14	21	35	63
16:00	28	20	116	212	371	154	52	8	60	38	242	104	156	230	103	102	54	19	32	65
17:00	37	15	74	133	385	303	55	11	61	60	157	171	202	195	256	90	100	24	41	58
18:00	31	14	117	220	782	217	77	4	122	210	389	341	302	193	111	118	119	87	84	63
19:00	32	34	86	137	766	304	51	29	110	388	415	616	501	348	117	130	123	113	103	92
20:00	46	25	108	190	621	290	72	107	181	524	462	836	619	432	121	131	81	208	148	96
21:00	56	57	109	161	979	383	97	83	304	469	479	960	619	330	426	77	88	164	163	73
22:00	53	61	117	173	1,049	265	193	219	436	657	440	898	779	416	389	26	154	107	165	184
23:00	25	96	132	168	884	262	221	450	775	778	458	972	783	418	278	70	148	199	341	160
24:00	27	96	132	167	627	222	377	422	602	683	448	722	807	196	162	129	88	192	198	238
Total	958	1,307	2,137	2,955	14,080	7,728	3,592	3,729	5,235	8,294	10,467	9,274	9,451	8,385	4,902	2,406	2,011	2,387	2,675	2,716

[a] Counting initiatied on 20 June at 1700 hours.
[b] Daily count unavailable. Total daily count was based on mean proportion of east bank counts for 24 and 29 June. Hourly distribution was based on mean proportion of hourly counts for 24 and 29 June.
[c] Daily count unavailable. Total daily count was based on mean number of east bank counts for 9 and 11 July. Hourly distribution was based on mean proportion of hourly counts for 9 and 11 July.

Appendix C. West bank Anvik River corrected sonar counts by sector, 19 June – 27 July, 1993.

West Bank Sector	19–Jun*	20–Jun	21–Jun	22–Jun	23–Jun	24–Jun	25–Jun	26–Jun	27–Jun	28–Jun	29–Jun	30–Jun	01–Jul	02–Jul	03–Jul	04–Jul	05–Jul	06–Jul	07–Jul
1	13	53	207	287	592	101	472	1,821	2,616	2,225	1,409	2,083	3,796	8,269	6,365	6,769	4,419	5,636	6,031
2	35	127	468	644	900	589	389	1,828	1,350	786	616	2,066	3,975	4,395	4,410	8,641	8,322	7,772	10,170
3	17	67	327	165	176	184	15	145	146	54	35	463	1,036	1,777	1,058	2,765	2,265	1,804	2,707
4	6	43	112	50	31	22	0	3	3	1	1	129	185	209	157	479	181	115	224
5	0	26	29	3	9	1	0	1	0	0	0	69	77	107	87	226	5	3	6
6	1	13	20	0	1	0	0	1	0	0	0	51	43	79	44	158	3	1	5
7	0	10	19	1	4	0	0	0	0	0	0	17	39	66	38	102	2	1	1
8	0	9	12	0	0	0	0	0	2	0	0	17	40	63	25	71	1	0	1
9	0	16	29	14	0	0	0	0	9	0	0	6	8	37	0	6	1	2	1
10	0	17	42	51	4	7	0	3	12	0	0	16	17	52	0	23	5	1	6
11	0	14	41	83	2	0	0	3	8	0	0	11	11	32	2	19	63	58	94
12	0	1	116	148	15	1	1	3	23	1	2	9	2	579	0	205	749	700	924
13	2	58	335	295	11	54	12	7	12	19	40	20	7	414	8	169	731	623	476
14	2	170	613	610	40	130	16	9	6	34	44	24	7	9	26	230	762	461	471
15	14	305	1,192	847	57	203	29	58	0	0	0	9	10	95	34	171	651	181	100
16	95	136	843	1,907	3,360	286	88	257	0	0	0	21	48	235	374	367	458	163	42
Total	185	1,065	4,405	5,105	5,202	1,578	1,023	4,139	4,187	3,120	2,147	5,011	9,301	16,418	12,628	20,401	18,618	17,521	21,259

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23–Aug–94:ssecvik.wk3

Appendix C. (p 2 of 2).

West Bank Sector	08-Jul	09-Jul	10-Jul	11-Jul	12-Jul	13-Jul	14-Jul	15-Jul	16-Jul	17-Jul	18-Jul	19-Jul	20-Jul	21-Jul	22-Jul	23-Jul	24-Jul	25-Jul	26-Jul	27-Jul
1	2,574	1,957	1,730	363	345	127	118	124	358	1,377	740	309	179	88	46	20	15	35	26	11
2	5,551	7,077	10,317	4,596	3,514	2,041	2,286	2,727	2,342	3,578	2,871	1,435	959	566	201	155	86	208	164	72
3	1,907	4,352	7,448	6,191	4,776	4,508	3,893	3,746	2,961	2,738	1,851	1,297	1,273	838	358	267	217	401	384	214
4	160	1,264	2,636	3,869	3,528	3,704	3,858	4,437	4,052	4,092	3,386	3,007	3,213	2,459	1,481	921	709	1,525	1,238	540
5	5	288	746	934	899	1,088	1,391	2,038	1,676	1,903	3,120	3,281	4,189	3,841	2,241	1,520	987	2,094	1,537	1,440
6	6	144	334	451	468	529	694	1,340	821	649	2,197	1,316	1,294	1,540	880	517	601	1,328	855	926
7	0	145	313	347	292	325	386	825	473	155	273	270	351	321	187	126	133	195	293	241
8	0	60	193	215	173	170	180	360	247	75	127	124	198	159	101	51	115	97	105	66
9	1	24	77	81	56	50	42	78	43	39	158	118	169	162	95	59	78	93	72	54
10	1	19	61	86	77	46	48	60	51	51	246	180	187	214	144	142	231	145	185	94
11	22	20	61	126	70	51	53	51	55	85	140	84	144	124	90	64	74	82	74	45
12	344	45	82	97	70	51	60	56	80	117	145	137	245	174	110	66	69	86	66	35
13	198	52	92	109	90	70	55	56	54	170	331	202	292	339	183	228	154	187	154	98
14	249	84	129	200	207	213	72	86	62	116	184	81	120	76	63	86	93	72	72	62
15	139	81	106	151	127	135	64	69	59	44	123	119	141	126	189	111	186	173	117	128
16	66	97	205	191	206	120	88	80	123	1,670	149	104	168	94	82	40	141	85	60	69
Total	11,223	15,709	24,530	18,007	14,898	13,228	13,288	16,133	13,457	16,859	16,041	12,064	13,122	11,121	6,451	4,373	3,889	6,806	5,402	4,095

[a] Counting initiated on 19 June at 1500 hours.

23-Aug-94:ssecvik.wk3

Appendix D. East bank Anvik River corrected sonar counts by sector, 19 June – 27 July, 1993.

East Bank Sector	19–Jun	20–Jun[a]	21–Jun	22–Jun	23–Jun	24–Jun	25–Jun[b]	26–Jun[b]	27–Jun[b]	28–Jun[b]	29–Jun	30–Jun	01–Jul	02–Jul	03–Jul	04–Jul	05–Jul	06–Jul	07–Jul
17		0	5,795	424	94	598	96	388	391	291	4	31	520	19	68	63	279	125	74
18		4	245	19	41	38	5	22	22	17	0	10	179	12	18	40	30	43	35
19		0	102	5	6	21	5	22	22	17	1	8	16	3	17	23	21	36	25
20		1	47	0	4	8	4	14	15	11	1	10	16	1	5	21	12	9	6
21		0	6	0	0	1	5	20	20	15	2	1	6	0	8	4	14	10	2
22		0	4	0	0	0	2	10	10	7	1	11	11	4	19	23	12	9	4
23		0	0	0	0	0	10	39	39	29	4	24	24	36	68	100	21	15	15
24		0	0	0	0	0	5	19	20	15	2	23	28	35	64	70	66	89	57
25		0	0	0	0	0	12	49	49	37	5	18	18	69	286	124	21	34	41
26		0	0	0	0	0	5	19	20	15	2	41	771	441	1,139	409	379	175	121
27		0	0	0	0	0	5	19	20	15	2	91	168	119	209	110	156	180	80
28		0	0	1	0	0	14	58	59	44	6	14	48	60	59	63	73	67	41
29		0	0	2	0	0	5	19	20	15	2	6	53	28	34	67	46	57	60
30		0	0	3	0	0	7	29	29	22	3	0	37	3	0	4	0	3	10
31		0	1	6	0	0	5	19	20	15	2	0	55	0	0	15	20	7	12
32		0	0	0	0	0	7	29	29	22	3	0	45	0	0	12	17	3	11
Total		5	6,200	460	145	666	192	775	785	587	40	288	1,995	830	1,994	1,148	1,167	862	594

23–Aug–94:ssecvik.wk3

Appendix D. (p 2 of 2).

East Bank Sector	08–Jul	09–Jul	10–Jul[c]	11–Jul	12–Jul	13–Jul	14–Jul	15–Jul	16–Jul	17–Jul	18–Jul	19–Jul	20–Jul	21–Jul	22–Jul	23–Jul	24–Jul	25–Jul	26–Jul
17	37	3	9	15	23	44	119	527	56	0	83	85	67	218	192	118	13	7	7
18	27	1	5	8	3	21	359	38	19	0	1	152	17	39	19	9	1	1	2
19	12	0	7	13	2	10	138	12	82	0	3	16	5	5	6	6	2	2	2
20	7	0	2	3	2	4	128	89	8	0	0	0	11	12	1	5	2	0	0
21	6	0	2	4	2	1	15	8	4	0	0	0	5	4	0	4	0	0	0
22	9	0	0	0	3	0	0	5	3	0	0	0	2	7	3	2	0	0	0
23	36	1	4	7	3	1	1	18	6	0	1	0	2	7	4	2	0	0	1
24	57	0	5	9	2	1	2	5	6	1	0	0	1	3	1	1	0	0	4
25	63	52	40	28	2	1	7	8	50	2	9	0	1	0	1	1	0	0	3
26	210	294	192	90	21	21	28	34	167	19	11	0	4	15	18	4	8	3	2
27	160	194	165	135	142	108	45	61	192	99	94	4	21	61	22	14	10	8	4
28	149	235	320	404	1,140	690	152	239	263	266	380	5	60	234	134	80	37	45	56
29	100	139	465	791	4,030	2,651	495	514	872	1,504	761	23	105	426	220	99	63	87	136
30	47	210	402	594	4,380	2,466	976	774	1,394	2,505	1,773	668	1,371	2,689	1,581	714	651	567	624
31	13	108	278	448	1,795	1,020	734	967	1,482	2,374	2,895	2,218	3,153	2,385	1,532	751	699	866	972
32	24	73	241	408	2,529	688	391	431	630	1,525	4,457	6,102	4,627	2,285	1,167	595	527	798	863
Total	957	1,310	2,137	2,957	14,079	7,727	3,590	3,730	5,234	8,295	10,468	9,273	9,452	8,390	4,901	2,405	2,013	2,384	2,676

23–Aug–94:ssecvik.wk3

Appendix E. Anvik River salmon beach seine catch by species, sex, and date, 1993.

Date	Number of Sets	Chum Salmon			Chinook Salmon			Pink Salmon			Non-salmon Species
		Male	Female	Total	Male	Female	Total	Male	Female	Total	
19-Jun											
20-Jun											
21-Jun											
22-Jun											
23-Jun											
24-Jun											
25-Jun											
26-Jun											
27-Jun											
28-Jun											
29-Jun	4	16	19	35	0	0	0	0	0	0	1 char; 1 grayling
30-Jun	1	19	13	32	0	0	0	0	0	0	1 grayling
01-Jul											
02-Jul	1	41	26	67	0	0	0	0	0	0	1 grayling
03-Jul	1	13	13	26	0	0	0	0	0	0	7 char; 6 grayling; 1 sucker
04-Jul	1	39	37	76	0	0	0	0	0	0	
05-Jul											
06-Jul	1	44	41	85	0	0	0	0	0	0	
07-Jul											
08-Jul											
09-Jul											
10-Jul	1	25	45	70	0	0	0	0	0	0	3 grayling
11-Jul	1	10	11	21	0	0	0	0	0	0	
12-Jul	1	32	18	50	0	0	0	0	0	0	2 char
13-Jul	1	7	13	20	0	0	0	0	0	0	
14-Jul											
15-Jul	1	37	35	72	0	0	0	0	0	0	5 char
16-Jul											
17-Jul											
18-Jul	1	24	42	66	0	0	0	0	0	0	1 char
19-Jul											
20-Jul											
21-Jul	1	11	12	23	0	0	0	0	0	0	1 whitefish
22-Jul											
23-Jul	1	7	10	17	0	0	0	0	0	0	2 grayling; 3 whitefish
24-Jul											
25-Jul											
26-Jul											
27-Jul											
Total	17	325	335	660	0	0	0	0	0	0	

Appendix F. Age and sex composition of Anvik River summer chum salmon, 1972 – 1993.

	Number of Fish[a]														
	Total Sample			Age 0.2			Age 0.3			Age 0.4			Age 0.5		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	167	153	320	0	0	0	25	37	62	138	115	253	4	1	5
1973	265	518	783	11	37	48	204	401	605	49	79	128	1	1	2
1974	245	157	402	12	24	36	197	120	317	34	12	46	2	1	3
1975	270	314	584	4	17	21	253	288	541	13	9	22	0	0	0
1976	281	320	601	5	4	9	43	35	78	233	281	514	0	0	0
1977	191	398	589	20	111	131	161	270	431	7	15	22	3	2	5
1978	289	263	552	0	1	1	210	180	390	79	82	161	0	0	0
1979	273	306	579	2	12	14	154	193	347	115	99	214	2	2	4
1980	167	258	425	0	1	1	147	226	373	20	31	51	0	0	0
1981	151	182	333	0	0	0	49	67	116	99	115	214	3	0	3
1982	117	265	382	4	17	21	75	181	256	37	65	102	1	2	3
1983	183	238	421	0	4	4	99	142	241	83	90	173	1	2	3
1984	138	215	353	2	6	8	117	189	306	19	20	39	0	0	0
1985	233	294	527	0	11	11	172	225	397	59	58	117	2	0	2
1986	205	281	486	0	2	2	59	89	148	143	186	329	3	4	7
1987	190	355	545	0	10	10	125	238	363	56	100	156	9	7	16
1988	180	351	531	1	30	31	129	282	411	48	37	85	2	2	4
1989	199	389	588	0	9	9	55	179	234	143	201	344	1	0	1
1990	172	227	399	3	12	15	98	169	267	67	45	112	4	1	5
1991	239	313	552	0	0	0	96	153	249	141	160	301	2	0	2
1992	162	262	424	0	3	3	39	98	137	115	154	269	8	7	15
1993[d]	325	335	660	1	3	4	140	201	341	106	81	187	6	8	14

–continued–

Appendix F. (page 2 of 2).

	Percent of Sample[b]														
	Total Sample			Age 0.2			Age 0.3			Age 0.4			Age 0.5		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	52.2	47.8	100.0	0.0	0.0	0.0	7.8	11.6	19.4	43.1	35.9	79.1	1.3	0.3	1.6
1973	33.8	66.2	100.0	1.4	4.7	6.1	26.1	51.2	77.3	6.3	10.1	16.3	0.1	0.1	0.3
1974	60.9	39.1	100.0	3.0	6.0	9.0	49.0	29.9	78.9	8.5	3.0	11.4	0.5	0.2	0.7
1975	46.2	53.8	100.0	0.7	2.9	3.6	43.3	49.3	92.6	2.2	1.5	3.8	0.0	0.0	0.0
1976	46.8	53.2	100.0	0.8	0.7	1.5	7.2	5.8	13.0	38.8	46.8	85.5	0.0	0.0	0.0
1977	32.4	67.6	100.0	3.4	18.8	22.2	27.3	45.8	73.2	1.2	2.5	3.7	0.5	0.3	0.8
1978	52.4	47.6	100.0	0.0	0.2	0.2	38.0	32.6	70.7	14.3	14.9	29.2	0.0	0.0	0.0
1979	47.2	52.8	100.0	0.3	2.1	2.4	26.6	33.3	59.9	19.9	17.1	37.0	0.3	0.3	0.7
1980	39.3	60.7	100.0	0.0	0.2	0.2	34.6	53.2	87.8	4.7	7.3	12.0	0.0	0.0	0.0
1981	45.3	54.7	100.0	0.0	0.0	0.0	14.7	20.1	34.8	29.7	34.5	64.3	0.9	0.0	0.9
1982	30.6	69.4	100.0	1.0	4.5	5.5	19.6	47.4	67.0	9.7	17.0	26.7	0.3	0.5	0.8
1983	43.5	56.5	100.0	0.0	1.0	1.0	23.5	33.7	57.2	19.7	21.4	41.1	0.2	0.5	0.7
1984	39.1	60.9	100.0	0.6	1.7	2.3	33.1	53.5	86.7	5.4	5.7	11.0	0.0	0.0	0.0
1985	44.2	55.8	100.0	0.0	2.1	2.1	32.6	42.7	75.3	11.2	11.0	22.2	0.4	0.0	0.4
1986	42.2	57.8	100.0	0.0	0.4	0.4	12.1	18.3	30.5	29.4	38.3	67.7	0.6	0.8	1.4
1987	34.9	65.1	100.0	0.0	1.8	1.8	22.9	43.7	66.6	10.3	18.3	28.6	1.7	1.3	2.9
1988	33.9	66.1	100.0	0.2	5.6	5.8	24.3	53.1	77.4	9.0	7.0	16.0	0.4	0.4	0.8
1989[c]	34.4	65.6	100.0	0.0	1.2	1.2	9.4	28.5	37.9	24.8	35.9	60.7	0.1	0.0	0.1
1990[c]	48.7	51.3	100.0	0.6	2.5	3.2	26.0	39.1	65.1	18.8	11.3	30.1	1.2	0.4	1.6
1991[c]	42.1	57.9	100.0	0.0	0.0	0.0	16.4	27.8	44.2	25.6	30.1	55.6	0.2	0.0	0.2
1992[c]	43.4	56.6	100.0	0.0	0.3	0.3	8.4	18.1	26.5	32.6	36.3	69.0	2.4	1.8	4.2
1993[c,d]	48.0	52.0	100.0	0.1	0.5	0.6	26.1	38.8	64.8	17.8	14.6	32.4	0.9	1.3	2.2

[a] Samples collected by carcass survey 1972–1981, by beach seine 1983–1992, and by both methods combined in 1982.
[b] Sample percentages not weighted by time period or escapement counts unless otherwise noted.
[c] Sample percentages weighted by time period and escapement counts.
[d] Sex compositon based on entire beach seine sample (n = 660). Age compostion based on readable scales (n = 546).

Appendix G. Age and sex composition of Anvik River chinook salmon escapement samples, 1972–1993.[a]

	Number of Chinook Salmon														
	Sample			Age 4			Age 5			Age 6			Age 7		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	10	5	15	0	0	0	8	0	8	2	5	7	0	0	0
1973	6	4	10	1	0	1	0	0	0	5	3	8	0	1	1
1974	0	0	0	–	–	–	–	–	–	–	–	–	–	–	–
1975	6	2	8	1	0	1	4	1	5	1	1	2	0	0	0
1976	33	12	45	6	0	6	25	5	30	2	7	9	0	0	0
1977	58	59	117	2	1	3	27	6	33	27	48	75	2	4	6
1978	36	41	77	13	0	13	10	1	11	13	39	52	0	1	1
1979	37	9	46	17	0	17	14	0	14	6	6	12	0	3	3
1980	41	42	83	19	1	20	21	22	43	1	16	17	0	3	3
1981	109	154	263	33	1	34	61	36	97	15	116	131	0	1	1
1982	100	38	138	47	1	48	47	5	52	6	32	38	0	0	0
1983	173	133	306	56 [b]	0	56	84	26	110	33	104	137	0	3	3
1984	162	114	276	29	4	33	108	30	138	25	74	99	0	6	6
1985	25	8	33	10	0	10	10	3	13	5	5	10	0	0	0
1986	53	89	142	0	1	1	44	27	71	6	48	54	3	13	16
1987	92	130	222	21	0	21	22	7	29	48	116	164	1	7	8
1988	173	73	246	75	0	75	70	24	94	26	41	67	2	8	10
1989	226	155	381	17 [b]	0	17	149	38	187	60	106	166	0	11	11
1990	252	148	400	106 [b]	0	106	86	18	104	56	119	175	4	11	15
1991	223	155	378	39	0	39	145	63	208	38	82	120	1	10	11
1992	185	130	315	30	0	30	113	7	120	40	120	160	2	3	5
1993	197	143	340	47	0	47	104	27	131	46	109	155	0	7	7

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23–Aug–94:c:\anvik\1993\kagevik.wk3

Appendix G. (page 2 of 2).

	Percent of Total Sample[c]														
	Sample			Age 4			Age 5			Age 6			Age 7		
Year	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1972	66.7	33.3	100.0	0.0	0.0	0.0	53.3	0.0	53.3	13.3	33.3	46.7	0.0	0.0	0.0
1973	60.0	40.0	100.0	10.0	0.0	10.0	0.0	0.0	0.0	50.0	30.0	80.0	0.0	10.0	10.0
1974	0.0	0.0	0.0	–	–	–	–	–	–	–	–	–	–	–	–
1975	75.0	25.0	100.0	12.5	0.0	12.5	50.0	12.5	62.5	12.5	12.5	25.0	0.0	0.0	0.0
1976	73.3	26.7	100.0	13.3	0.0	13.3	55.6	11.1	66.7	4.4	15.6	20.0	0.0	0.0	0.0
1977	49.6	50.4	100.0	1.7	0.9	2.6	23.1	5.1	28.2	23.1	41.0	64.1	1.7	3.4	5.1
1978	46.8	53.2	100.0	16.9	0.0	16.9	13.0	1.3	14.3	16.9	50.6	67.5	0.0	1.3	1.3
1979	80.4	19.6	100.0	37.0	0.0	37.0	30.4	0.0	30.4	13.0	13.0	26.1	0.0	6.5	6.5
1980	49.4	50.6	100.0	22.9	1.2	24.1	25.3	26.5	51.8	1.2	19.3	20.5	0.0	3.6	3.6
1981	41.4	58.6	100.0	12.5	0.4	12.9	23.2	13.7	36.9	5.7	44.1	49.8	0.0	0.4	0.4
1982	72.5	27.5	100.0	34.1	0.7	34.8	34.1	3.6	37.7	4.3	23.2	27.5	0.0	0.0	0.0
1983	56.5	43.5	100.0	18.3	0.0	18.3	27.5	8.5	35.9	10.8	34.0	44.8	0.0	1.0	1.0
1984	58.7	41.3	100.0	10.5	1.4	12.0	39.1	10.9	50.0	9.1	26.8	35.9	0.0	2.2	2.2
1985	75.8	24.2	100.0	30.3	0.0	30.3	30.3	9.1	39.4	15.2	15.2	30.3	0.0	0.0	0.0
1986	37.3	62.7	100.0	0.0	0.7	0.7	31.0	19.0	50.0	4.2	33.8	38.0	2.1	9.2	11.3
1987	41.4	58.6	100.0	9.5	0.0	9.5	9.9	3.2	13.1	21.6	52.3	73.9	0.5	3.2	3.6
1988	70.3	29.7	100.0	30.5	0.0	30.5	28.5	9.8	38.2	10.6	16.7	27.2	0.8	3.3	4.1
1989	59.3	40.7	100.0	4.5	0.0	4.5	39.1	10.0	49.1	15.7	27.8	43.6	0.0	2.9	2.9
1990	63.0	37.0	100.0	26.5	0.0	26.5	21.5	4.5	26.0	14.0	29.8	43.8	1.0	2.8	3.8
1991	59.0	41.0	100.0	10.3	0.0	10.3	38.4	16.7	55.0	10.1	21.7	31.7	0.3	2.6	2.9
1992	58.7	41.3	100.0	9.5	0.0	9.5	35.9	2.2	38.1	12.7	38.1	50.8	0.6	1.0	1.6
1993	57.9	42.1	100.0	14.9	0.0	14.9	33.0	7.9	41.0	13.5	32.1	45.6	0.0	2.1	2.1

[a] Samples collected mainly by carcass survey. In some years a very few fish were also collected by beach seine or hook and line.
[b] Includes one age–3 male.
[c] Sample percentages not weighted by time period or escapement counts.

23–Aug–94:c:\anvik\1993\kagevik.wk3

Appendix H. Climatological and hydrological observations, Anvik River sonar site, 1993.

Date	Time	Precip. (Code)[a]	Wind (Direction and Velocity)	Cloud Cover (Code)[b]	Temperature Air Min. °C	Temperature Air Max. °C	Temperature Water °C	Water Gauge Actual (ft.)	Water Gauge Relative (ft.)	Water Gauge Relative (cm)	Water Color (code)[c]	Remarks
19–Jun	18:00	N	N 5–10	1	[d]	18	12	3.00	0.00	0.0	Lt	nice day; Min/Max thermometer unavailable
20–Jun	18:26	N	N 5–10	1	[d]	18	12	2.88	−0.12	−3.7	Lt	
21–Jun	18:00	N	N 5–15	1	[d]	20	14	2.70	−0.30	−9.1	Lt	nice day
22–Jun	18:02	T	S 5–10	3	[d]	12	12	2.54	−0.46	−14.0	Lt	thunder showers
23–Jun	19:00	N	S 5–15	3	[d]	18	13	2.46	−0.54	−16.5	Lt	windy and cloudy
24–Jun	18:25	N	calm	3	[d]	20	14	2.35	−0.65	−19.8	Lt	cloudy and muggy
25–Jun	18:00	N	S 5–15	3	[d]	18	14	2.20	−0.80	−24.4	Lt	cloudy
26–Jun	20:00	I	SE–10	4	[d]	14	14	2.00	−1.00	−30.5	Lt	cloudy and rain showers
27–Jun	18:25	I	SE–5	3	[d]	15	12	2.00	−1.00	−30.5	Lt	
28–Jun	18:10	I	SE 5–10	4	[d]	15	12	2.10	−0.90	−27.4	Lt	
29–Jun	18:40	N	S 5–10	4	[d]	15	12	1.94	−1.06	−32.3	Lt	
30–Jun	18:00	N	S 0–5	3	[d]	18	12	1.78	−1.22	−37.2	Lt	cloudy, occassional sun
01–Jul	18:27	N	S 10–15	3	[d]	20	14	1.64	−1.36	−41.5	Lt	
02–Jul	18:00	R	S 15–25	4	[d]	15	13	1.50	−1.50	−45.7	Lt	windy with rain
03–Jul	18:00	I	S 5–10	4	10	15	13	1.49	−1.51	−46.0	Lt	first day with Min/Max thermometer
04–Jul	18:00	I	S 5–10	4	9	13	12	1.50	−1.50	−45.7	Lt	cold, more rain than not
05–Jul	19:00	I	S 10–15	4	7	17	12	1.56	−1.44	−43.9	Lt	rain
06–Jul	18:15	N	calm	3	10	14	12	1.46	−1.54	−46.9	Lt	cool and partially clear
07–Jul	18:31	N	Var 5	3	9	15	13	1.39	−1.61	−49.1	Lt	breezy
08–Jul	18:45	I	Var 0–5	4	9	17	11	1.38	−1.62	−49.4	Lt	dreary and drizzly
09–Jul	17:53	N	Var 0–5	2	10	21	16	1.31	−1.69	−51.5	Lt	nice day
10–Jul	18:00	N	Var 0–5	3	10	25	15	1.19	−1.81	−55.2	Lt	
11–Jul	18:30	N	Var 0–10	2	10	31	17	1.09	−1.91	−58.2	Lt	hot
12–Jul	18:00	I	Var 0–5	2	15	26	17	1.00	−2.00	−61.0	Lt	hot
13–Jul	17:45	I	S 15	4	15	27	17	0.92	−2.08	−63.4	Lt	overcast all day
14–Jul	18:50	N	calm	3	10	19	15	0.88	−2.12	−64.6	Lt	nice day
15–Jul	18:00	N	S 5–10	3	9	19	15	0.81	−2.19	−66.8	Lt	
16–Jul	18:30	N	S 5–10	3	10	22	16	0.76	−2.24	−68.3	Lt	nice day
17–Jul	18:00	N	S 5–10	2	12	23	16	0.70	−2.30	−70.1	Lt	clear and breezy
18–Jul	19:03	I	S 0–5	3	9	31	18	0.64	−2.36	−71.9	Lt	cloudy and hot
19–Jul	18:20	N	S 5–10	1	10	28	19	0.60	−2.40	−73.2	Lt	breezy and hot
20–Jul	18:35	N	S 5	2	16	31	19	0.54	−2.46	−75.0	Lt	breezy and hot
21–Jul	18:00	N	S 10	1	22	37	20	0.48	−2.52	−76.8	Lt	hot; 89° F at Townsend's Lodge
22–Jul	18:30	N	S 5	1	12	32	20	0.44	−2.56	−78.0	Lt	hot
23–Jul	18:50	N	calm	3	16	29	19	0.34	−2.66	−81.1	Lt	weather is changing
24–Jul	17:50	N	Var 10	3	9	23	18	0.30	−2.70	−82.3	Lt	
25–Jul	18:30	I	Var 15	3	14	29	18	0.29	−2.71	−82.6	Lt	
26–Jul	18:30	N	Var 15	1	16	26	18	0.24	−2.76	−84.1	Lt	

[a] Precipitation code for the preceding 24–h period: N = No precipitaion; I = Intermittent rain; R = Continuous rain; S = Snow; S&R = Snow and rain mixedH = Hail; and T = Thunder showers.
[b] Instantaneous cloud cover code: 0 = No observation; 1 = Clear sky, cloud cover not more than 10% of sky; 2 = Cloud cover not more than 50% of sky; 3 = Cloud cover more than 50% but less than 100% of sky; 4 = Completely overcast; and 5 = Fog or thick haze.
[c] Instanteous water color code: Cl = Clear; Lt = Light brown; Br = Brown; Dk = Dark brown; and Tr = Turbid: murky or glacial.
[d] Minimum/Maximum thermometer unavailable. Instantaneous temperature reading late in the afternoon was assumed to be maximum temperature for that day.